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Waterborne Seismic Reflection Investigation of Pool 3, Monongahela River, Pennsylvania

Report 1: Interpretation of Geophysical Data

by Keith J. Sjostrom, Rodney L. Leist

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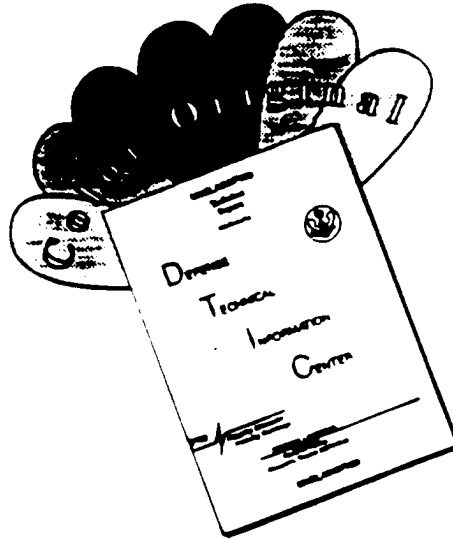
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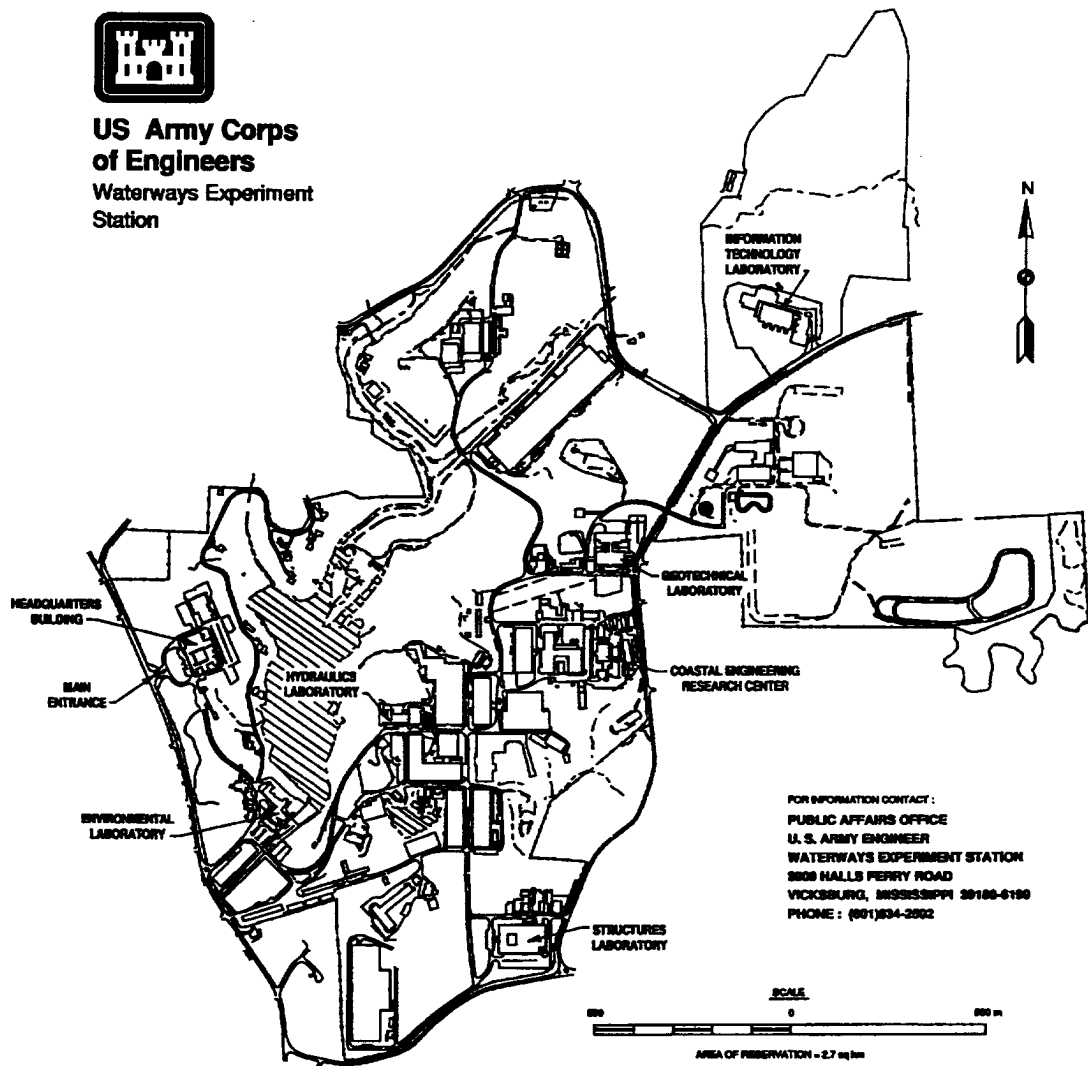
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Preface

A seismic reflection and side scan sonar investigation was conducted within Pool 3 of the Monongahela River, Pennsylvania, by personnel of the Geotechnical Laboratory (GL), U.S. Army Engineer Waterways Experiment Station (WES), during the period 19-27 October 1994. The investigation was performed under sponsorship of the U.S. Army Engineer District, Pittsburgh (CEORP). The CEORP Project Coordinators at the time of the survey were Ms. Nancy L. Taylor and Maria K. Novak.

The overall test program was conducted under the general supervision of Dr. W. F. Marcuson, Director, GL, and Dr. A. G. Franklin, Chief, Earthquake Engineering and Geosciences Division (EEGD). Mr. Keith J. Sjostrom was the principal investigator. This report was prepared by Messrs. Sjostrom and Rodney L. Leist under the supervision of Mr. J. R. Curro, Jr., Chief, Engineering Geophysics Branch, GL. Data acquisition and instrumentation support was provided by Mr. Richard G. McGee, Hydraulic Structures Division (HSD), Hydraulics Laboratory (HL), and Mr. Thomas S. Harmon, Jr., EEGD, GL. Data analysis assistance during this study was provided by Ms. Darla C. McVan, HSD, HL, and Ms. Claire R. Livingston, Computer Services Corporation. Data presentation and graphics support was provided by Ms. Lori M. Davis, EEGD, GL, and Mr. Grady A. Holley, Jr., Information Management Systems, Inc.

Acknowledgment is made to Ms. Nancy L. Taylor, CEORP, for her assistance during this field study. CPT Robert Sheraton of New Castle, DE, is especially appreciated for piloting the WES research vessel 'Waterways Explorer' during the geophysical survey. Appreciation is also expressed to personnel of the Beach Club Marina, New Eagle, PA, for their support and assistance.

At the time of publication of this report, Director of WES was Dr. Robert W. Whalin. Commander was COL Bruce K. Howard, EN.

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Conversion Factors, Non-SI to SI Units of Measurement

Non-SI units of measurement used in this report can be converted to SI (metric) units as follows:

Multiply	By	To Obtain
feet	0.3048	meters
miles (U.S. statute)	1.6093	kilometers

1 Introduction

Background

At the request of the U.S. Army Engineer District, Pittsburgh (CEORP), the U.S. Army Engineer Waterways Experiment Station (WES) conducted a waterborne seismic reflection survey within Pool 3 of the Monongahela River, Pennsylvania (see Figure 1). Pool 3 is bounded by Locks and Dams 3 and 4 which are located at river mile (RM) 23.8 at Elizabeth, PA and RM 41.5 at Charleroi, PA, respectively. The locks and dams along the Monongahela River under consideration to be upgraded or replaced in order to provide better navigation along the waterway. Therefore, information concerning the thickness, distribution, and geologic characteristics of bottom and subbottom sediments along the waterway are necessary for preparing plans and specifications for the proposed deepening of the of the channel. Additional information about the location of geologic interfaces, delineation of fine-grained sediments areas, identification of thin sediment layers, and location of possible dredging or navigation hazards are also needed for project planning.

Purpose and Scope

The objective of the geophysical investigation is to quantify with depth the lateral limits of bottom and subbottom fine-grained sediments in terms of material density and general soil classification to depths of 15 ft below the bottom surface. The results are intended to supplement previously obtained soil samples by providing continuous profile line coverage of the bottom and subbottom sediments along the length of the project area. This will facilitate the accurate positioning of any additional borings that may be required. Report 1 of this study intends to delineate subbottom sediment interfaces, identify river bottom features and general sediment characteristics, and provide preliminary sediment characterization based on available core information. Report 2 of the investigation will concentrate on detailed sediment characterization based on computed acoustic impedance values and inferred sediment density values and material types. Report 2 will follow the in depth sediment analysis of a series of cores strategically collected within the project area. Overall, the seismic reflection data will provide better descriptions of

variations in the actual subbottom conditions and help identify the differing sediment layers. Two high resolution subbottom profiling systems and a side scan sonar system were used to meet the primary objectives of the investigation.

Overview of Site Geology

Pool 3 of the Monongahela River is located in the Appalachian Plateau geomorphic province and characterized as a mature plateau of moderate relief dominated by rounded hills and ridges (Greene et al. 1993). Local relief ranges from 200 to 300 ft. The bedrock formations at this site are comprised of horizontal to slightly dipping sedimentary strata of Pennsylvanian age. The bedrock formations, as described by the U.S. Army Engineer District, Pittsburgh (1988), consist of variable series of claystones, argillaceous limestones, siltstones, shales, sandstones, and coal seams. The bedrock is fine-grained and highly fractured.

Soils at the site range from 30 to 45 ft in thickness and consist primarily of alluvial deposits of Quaternary age. Clays and sands are the major soil types but layers of silts, gravels, and cobbles are also present. The alluvial sediments are deposited in thin layers and lenses with a high degree of horizontal and vertical variability (U.S. Army Corps of Engineers 1988).

2 Technical Approach

Seismic Reflection Method

Acoustic subbottom reflection data are produced when a source of acoustic energy is deployed just below the water surface and fired. In a homogeneous medium, the acoustic waves extend uniformly in all directions from the source in which the advancing wavefronts are spherical surfaces centered at the source and perpendicular to the direction of propagation. At large distances from the source, the wave fronts may be represented by rays as shown in Figure 2. When the acoustic energy arrives at a boundary between two materials of differing properties and elastic velocities, part of the energy will be reflected back towards the surface and part transmitted downward into the second medium (see Figure 2). Portions of the transmitted energy will also undergo absorption or attenuation in the material while the wavefront propagates through to the next stratigraphic boundary.

The amplitudes of the incident, reflected, and transmitted wave energies vary with respect to the density and velocity of the materials through which the wave energy is propagating. The ratio between the amplitudes of incident and reflected wave energy is called the reflection coefficient (R) and is defined as:

$$R = \sqrt{\frac{A_R}{A_I}}$$

where A_R and A_I are the amplitudes of the reflected and incident wave energy, respectively. Reflected wave energies are detected using hydrophones or piezoelectric transducers which convert changes in water pressure due to the acoustic wavefronts into electrical impulses. The electrical signals are amplified, filtered, and recorded using a shallow seismic, digital data acquisition system.

The measured amplitudes of the reflected acoustic waves will vary depending on the angle of incidence, but for normal incidence, the reflection coefficient is also expressed by the equation at the top of the next page:

$$R = \frac{(Z_{i+1} - Z_i)}{(Z_{i+1} + Z_i)}$$

where Z is the acoustic impedance value of the layer and 'i' and 'i+1' identify adjacent stratigraphic layers (see Figure 2). The acoustic impedance of a sediment is defined as the product of the material density (ρ_i) and transmission velocity (V_i) and represents the influence of the material's characteristics on reflected and transmitted wave energy. Specifically,

$$Z_i = \rho_i V_i$$

where 'i' identifies the appropriate layer. Therefore, when there is a distinct contrast between layers, high amplitude reflections will be generated at the interface. However, at a boundary between two materials in which the transmission velocities and densities vary in such a manner that Z_i and Z_{i+1} have similar values, no reflections would be observed.

Using the relationships above, the acoustic impedance values of bottom and subbottom sediments may be determined from ratios of the measured incident and reflected wave energy amplitudes as shown below.

$$\sqrt{\frac{A_R}{A_I}} = \frac{(Z_{i+1} - Z_i)}{(Z_{i+1} + Z_i)}$$

At the water-sediment interface, the acoustic impedance of the water is a constant of known value. Therefore, inserting the impedance value for water along with measured amplitudes of the seismic signals into the above equation, the acoustic impedance of the bottom surface sediments can be calculated. Likewise, once the impedance of the uppermost sediment layer is determined, the impedance of the remaining sediment facies may also be computed using the equation

$$Z_{i+1} = \frac{Z_i * (1+R)}{1-R}$$

where R is the computed reflection coefficient between layers 'i' and 'i+1'. If the seismic velocities of the sediment material comprising each layer are also known, then the material density may also be derived. This is strictly a

simplified overview of the concept. It is also important to note that factors such as signal attenuation and transmission loss have not been taken into account in the above equations. For a more in depth discussion, refer to Telford (1976).

The relationship between acoustic impedance and specific soil properties has been empirically based on an extensive database of average impedance values versus sediment characteristics (Hamilton 1970, 1972; Hamilton and Bachman 1982). Figure 3 illustrates the general relationship between acoustic impedance and density values for marine sediments (Hamilton and Bachman 1982). Table 1 outlines the relationships between soil type, acoustic impedance, and density by also incorporating the work of Caulfield and Yim (1983). These relationships, however, are based primarily on deep ocean, surficial marine sediments and not riverine sediment environments. The derived sediment density values and implied soil classification are correlated with available ground truth information for verification.

Despite the simplistic overview of the basic principles involved, the analysis and interpretation of seismic reflection data requires great skill. Besides the subjectivity involved in selecting reflection horizons from the amplitude records, other factors may also complicate interpretation. One factor is frequent lithologic changes in the near-surface sediments in which numerous reflection horizons exist; each having differing reflection coefficients. Surface and subsurface irregularities may also cause the incident and reflected signals to scatter away from the receiver such that reflected events may have anomalously low reflection coefficients or be completely masked. But under favorable conditions when the geologic structure is not too complicated and noise is minimized, distinct reflections can be identified and information regarding the sediment characteristics can be derived.

Side Scan Sonar Operation

Side scan sonar is an acoustic imaging device used to provide wide-area, large-scale images of the bottom of a body of water. The system consists of an onboard recording system and control modules, an underwater sensor (typically referred to as a towfish), and a cable linking the two units (see Figure 4). During survey operations, the side scan recorder continually charges capacitors in the towfish at set quantities determined as a function of the imaging range. The range may be adjusted between 25 and 600 m. At discrete time intervals, the recorder transmits this stored power to the transducers in the towfish which in turn emit an acoustic pulse having a frequency of either 100 or 500 kiloHertz (kHz). The acoustic signals propagate through the water over the set imaging range and reflect off differing interfaces along the bottom surface. The returning signals are received at the transducers, amplified using a time varied gain function, and recorded. The recorder performs further filtering, amplification, and digitizing functions before calculating the proper

position of the signals on the final record. The recorder prints out and stores the resultant signature one scan at a time to provide a continuous image of the bottom surface along the survey line and, as a function of signal amplitude, denote bottom features and variations in site characteristics. Further information concerning the side scan sonar theory of operation may be found in the text 'Sound Underwater Images' (Fish and Carr 1990).

The printed amplitude signatures received from various bottom features can be qualitatively interpreted for the feature geometry, identification, and possible composition. The reflectivity potential of an underwater surface is a function of the side scan sonar's beam angle of incidence as it encounters that target. When the acoustic pulse is normal to a surface, more energy returns to the towfish than when a beam strikes at a differing angle. This angle of incidence along with the surface roughness are the primary reasons for dark and light areas on the sonar record. The various intensities of these shades assist in better record interpretation. The signal gain and range setting are continually adjusted during a survey to highlight and enhance the river bottom features. Cultural features such as exposed pipelines, bulkheads, or submerged debris are easily imaged typical survey conditions. Sediments such as sandy or gravelly material typically produce darker gray patterns on the side scan record whereby lighter shades may be indicative of more silty or clayey material. However, the beam angle, towfish path, survey vessel speed, signal gain, and other physical parameters may all affect the appearance and resolution of the side scan sonar record.

Geophysical Survey

Maps showing the location of the five geophysical survey lines in Pool 3 are presented in Figures 5 through 13. The survey lines, denoted as PP1 through PP5, were performed parallel to the channel centerline with line PP1 conducted along the channel centerline. The survey lines are approximately 17 miles in length and nominally spaced 100 ft apart. All survey lines were performed in the upstream direction (against the river current) with the exception of line PP4. In certain areas, survey line length and/or position were also dependent on water depth and river traffic.

Survey Methodology

Acoustic energy was generated by two high resolution subbottom profiling systems. The first system was operated at frequencies of 3.5 and 7.0 kHz and is typically called a 'pinger' because of the audible noise it makes during operation. The high-resolution 'pinger' system was mounted on the hull of the research vessel and used as the primary investigative tool. In an effort to detect and delineate the thin sediment layers and bedding planes in the

Monongahela River, the 'pinger' was operated at a tuned frequency of 7.0 kHz and total power of 5.0 kilowatts throughout most of the study. In general, higher operating frequencies permit greater resolution of the riverine sediments but shallower depths of energy penetration depending on the characteristics of the subbottom material. The source/ receiver separation was six feet and each set of transducers were positioned approximately three feet below the water surface. A total trace length of 700 samples were digitally acquired every 34 or 42 microseconds which corresponds to sampling rates of either 21 or 16 samples/microsecond, respectively. These sampling rates in turn provide an effective depth of subsurface exploration of nominally 10 to 20 ft below the bottom surface. The 'pinger' system was also operated at 3.5 kHz in order to investigate deeper into the subsurface even though the resolution would be slightly diminished. Surveys using this frequency were performed only along survey lines PP1 and PP2. The second system, a high definition 'boomer' system and hydrophone, provided an output frequency range of 0.5 to 2.0 kHz with which to interrogate the subbottom sediment and rock structure. The electro-mechanical source is mounted on a sled and, along with the hydrophone, was towed approximately 70 ft behind the research vessel during the investigation. During data collection, a total trace length of 700 samples were collected every 52 microseconds (sampling rate = 13 samples/microsecond) resulting in an approximate depth of exploration of 50 ft below the bottom surface. The 'boomer' system was used only along survey lines PP1 through PP3.

The side scan sonar unit was operated only along survey lines PP1 through PP3. The purpose of the sonar survey was to provide images of the river bottom surface to assist in the mapping of general sediment characteristics and not necessarily to delineate pipeline crossings, submerged debris, or other cultural features. The towfish was positioned at a depth of six feet below the water surface and operated at a frequency of 100 kHz. The imaging range was typically 100 to 150 m in order to provide bank-to-bank resolution of the river bottom. Fix points are printed incrementally along the side scan records in order to correlate the data with the positioning information.

Positioning information for each survey line was provided using Differential GPS and recorded concurrently during seismic data acquisition. Precision bathymetric data is also simultaneously collected during each survey. River bottom elevations are referenced to Mean Sea Level (MSL) for each lock and dam facility using daily pool level information and the source/ receiver transducer geometry. Pool levels at the time of the survey are listed in Table 2.

3 Data Analysis

Data Analysis and Presentation

Continuous subbottom profiles of the acoustic reflection amplitudes obtained using the high resolution profiling systems for surveys performed in Pool 3 are plotted to illustrate interpreted sediment interfaces and lateral variations of the subbottom reflection signatures. The seismic amplitude records collected along each survey line using the high-resolution 'pinger' system operating at a frequency of 7.0 kHz were delivered to CEORP project engineers in May 1995. The seismic records are annotated with survey information, data file numbers, and available core locations. The location of the seismic survey lines or a particular data file are graphically displayed on the survey track line maps in Figures 5 through 13 or listed in Appendices A through E for survey lines PP1 through PP5, respectively.

Data from the seismic surveys are also presented in profile line form to illustrate the measured depth to the river bottom surface and the depths to any interpreted sediment interfaces. The depth to the river bottom was measured using a 200 kHz fathometer during the seismic survey. The depths to the detected geologic interfaces are determined by measuring the traveltimes of the transmitted and reflected signals on the amplitude records while taking into account the source/receiver separation and acoustic velocities of the overlying sediment units. The depths to the detected interfaces along surveys PP1 through PP5 are illustrated in Diagrams F-1 through F-34 in Appendix F. Sediment interface depths may be adjusted to elevation above mean sea level (MSL) by taking into account daily river level elevations for Pool 3. These elevations are listed in Table 2. Referring to each figure in Appendix F, the labeled black dots at the top of each profile denote the survey track line and direction. Each dot represents the beginning of every third seismic data file recorded in order to give an indication of the data coverage along each survey line and assist in correlating the raw data and interpreted results. The associated label is the data file number. Appendices A through E present the location, corrected water depth, river bottom elevation in feet MSL, and side scan sonar fix points for the appropriate data file number along survey lines PP1 through PP5, respectively.

Spatial relationships for bottom and subbottom sediments interpreted as having similar acoustic signatures are presented on maps of the project area. These zones are correlated to the seismic data files for each survey line which in turn correspond to the positioning data listed in Appendices A through E. Categorical grouping and classification of portions of the river is completed through the use of the seismic amplitude records illustrating the bottom and subbottom acoustic signatures, side scan sonar images of the river bottom, and preliminary density estimates of the bottom sediments as derived from existing borings and geoacoustic modeling. These areas are discussed in more detail in Chapter 4.

Limitations in interpretation

The sediment interpretations described herein are measured from data collected with a remote sensing technique and should not be considered absolute measurements. As with any geophysical technique, there are limitations involved with the seismic reflection technique. Some of these limiting factors are outlined below and also described in further detail in McGee et al. (1995). An additional degree of uncertainty is introduced because of the relatively few cores available, none with detailed sediment analysis, to verify the acoustically derived interpretations. Additional cores for detailed sediment analysis will be collected in July 1995 to provide insitu data to assist in verifying the results.

- a. *Signal-to-noise ratio.* The ability of this technique to accurately detect subbottom layers is a function of the data quality. Data having a low signal-to-noise ratio will produce poor quality results or no results at all. The data quality along each survey line was generally good. However, there were areas of poor signal-to-noise data caused by equipment malfunction, such as along survey PP2 (files 2240-2960), and boat motor noise during vessel maneuvering and turning.
- b. *Layer detection and resolution.* Unique sediment interfaces can be detected only when a distinct difference in impedance exists between materials. Gradual changes in material type, such as coarse silt to fine sand, may not result in an impedance differential large enough to produce a reflection. Irregular surfaces of reflection horizons scatter the reflected signals away from the receiver such that interfaces may be poorly defined. Vertical resolution of sediment units and depth of exploration are also dependent on the frequency of the acoustic wave. As stated earlier, higher operating frequencies allow better resolution of the subbottom layers but shallower depths of energy penetration depending on the characteristics of the bottom and subbottom material. In sediments having high attenuation rates such as sands or gravels, higher frequencies are dissipated at a higher rate than low frequency signals and, therefore, layer resolution is further degraded. Signal correlation and enhancement algorithms are typically used to improve the signal-to-noise ratio and interface detection. A highly reflective bottom layer,

such as compacted sand or some organic sediments, will also limit energy penetration.

Determining a depth to an interface requires measurement of the travel-times of the transmitted and reflected wave while taking into account the acoustic velocities within the overlying materials. The accuracy of these results is somewhat restricted because of the specific pulse lengths of the acoustic signals. The 'pinger' and 'boomer' devices have well-defined acoustic pulse lengths and are able to resolve an interface to within approximately ± 1.0 and ± 2.0 ft, respectively. The error bounds of the measured river bottom depths is less than ± 0.5 ft because the acoustic device used operates at a much greater frequency, namely 200 kHz.

- c. *Acoustic footprint.* The term 'footprint' refers to the circular area of the river bottom sensed by the acoustic device during a given pulse transmission. The 'footprint' is primarily dependent on the beam angle of the acoustic device. Using an average water depth of 15 ft, the acoustic 'footprint' of the 'pinger' system is approximately 3 ft in diameter when the survey vessel is not moving. During survey conditions, the footprint increases dramatically. This is in stark contrast to the area sampled with a drill hole. Therefore, it is easy to see that in highly variable geologic conditions, such as river sediments, the acoustic and insitu results may not always agree precisely.
- d. *Side scan sonar analysis.* As mentioned in the section titled "Side Scan Sonar Operation", the beam angle of the signal, towfish path, survey vessel speed, signal gain, and other physical parameters of the equipment and river bottom all affect the appearance and resolution of the side scan sonar record. During this investigation, the resolution of the river bottom sediment and characteristics is good.

This method of acoustically detecting and deriving the geologic interfaces, river bottom geometry, and soil type interpretations represents an geophysically-based engineering solution to the problem of remotely assessing the physical characteristics of riverine sediments. The technique is not capable of assessing every geoacoustical situation and therefore the aforementioned limitations must be remembered.

Existing Borehole Information

Since 1989, numerous exploratory cores have been completed during the Lower Monongahela River Study to investigate the geotechnical and environmental parameters of the insitu sediments. The core information was collected at distinct locations to determine sediment characteristics, geotechnical parameters for lock and dam relocation or rehabilitation, and environmental aspects

in areas suspected of chemical contamination. However, only a few of these cores are located within the navigable channel. The approximate locations of the cores used in this investigation are illustrated on the geophysical survey track line maps shown in Figures 5 through 13. A summary of the bottom and subbottom sediment information for each core, which includes visual soil classification and depth to sediment interfaces, are presented in Tables 3 and 4. None of the insitu sediment information provided prior to the study have measured density values.

Sediment Density Estimation

Empirical relationships between acoustically derived geologic parameters (reflection coefficients, acoustic impedance, sediment velocity) and laboratory measured sediment characteristics (soil type, density, porosity, grain size) have been studied for the past four decades. Incorporating the sediment information available from existing cores collected in the Monongahela River and databases outlining seismic results versus sediment characteristics (Hamilton and Bachman 1982; Caulfield and Yim 1983), seismic reflection data analyzed to provide estimates of bottom and subbottom sediment density and classification. Report 1 of this study intends to provide gross sediment classification of the bottom and subbottom sediments using the seismic amplitude records and available core information. Preliminary river bottom density values will be derived in part via Table 1 by comparing initial estimates of acoustic impedance and sediment classification. Report 2 of the investigation will concentrate on detailed sediment characterization based on computed acoustic impedance values using the geoacoustic modeling procedures described in McGee et al. (1995) for data with high signal to noise ratios. The second part of the study will follow the in depth sediment analysis of a series of cores strategically collected within the project area.

4 Results of Investigation

Interpretation of the seismic reflection data is based on variations and contrasts of the acoustic signatures along each survey, available core information, side scan sonar information, and preliminary estimates of bottom sediment density values. The approximate 17 miles of project area are divided into areas in which the bottom and subbottom sediments and acoustic characteristics are similar. A total of 35 distinct areas have been delineated with the zones outlined in Figures 14, 16, 19, 24, 27, 31, 34, 37, and 40. Portions of the actual seismic records are included with the discussion to help illustrate the bottom and subbottom sediment representations being described. Areas of interest will be referenced according to seismic data file numbers which in turn can be translated to an Easting/Northing position or side scan sonar fix point using Appendices A through E. Analysis of the project area will begin near Lock and Dam 3 and progress upstream to Lock and Dam 4.

The side scan sonar was used in conjunction with the seismic equipment to provide an image of the channel bottom along the length of the project area. Side scan sonar data was collected only along survey lines PP1 through PP3 with each survey providing bank-to-bank coverage in the narrow river channel. Each record is analyzed and interpreted to investigate the following: general channel bottom features, gross soil classification, utility crossings, and other anomalous features. Areas of note are referenced with fix point numbers which can be correlated to positioning or seismic data file numbers using Appendices A through E. It should be remembered that the side scan sonar provides minimal, if any, subbottom information.

The interpreted results as stated and displayed in the plots and profiles highlight variabilities within the river bottom sediments, identify sediment interfaces, resolve sediment layering, and outline the river bottom features. The information pertaining to sediment characterization (material density, soil type, etc.) are *strictly preliminary* estimates and should not be used for detailed project design but rather as an aid to assist the project engineer in interpreting the results. The sediment characterization results will be refined upon receipt of the detailed laboratory core analysis.

Interpreted Areas MR-1 Through MR-35

Area MR-1. Area MR-1 is located between RM 23.9 and RM 24.1 at the start of the geophysical survey nearest the left-descending riverbank as shown in Figure 14. Seismic reflection signals have low to moderate amplitudes and the side scan sonar signatures illustrate little texture. These acoustic characteristics are indicative of sediments having finer grained components such as clays, silts, and very fine sands. Referring to some of the nearby cores, silty sediments are found at or near the surface; characteristic of material that accumulates behind dams or in backwater areas. Preliminary bottom density estimates range from 1.6 to 1.8 g/cm³. A faint subbottom interface is detected in this area at a depth of approximately two feet below the bottom surface.

Area MR-2. Similar bottom and subbottom acoustic characteristics are detected from the start of the survey (RM 23.9) to approximately RM 24.4. This reach is denoted as area MR-2 and is located as shown in Figure 14. The seismic reflection bottom signatures overall have moderate to high amplitudes and form highly variable zones and pockets. A well-defined interface is detected 1 to 3 ft below the bottom surface as shown in Diagrams F-1, F-8, and F-15 (see Appendix F) for survey lines PP1 through PP3, respectively. A representative seismic record along survey line PP1 (files 0010-0030) near RM 24.2 is illustrated in Figure 15. The detected subbottom layer thins towards each riverbank and upstream such that the layer is not present along survey line PP5. Core R-02, taken within this area near the edge of the channel, indicates a thin silt layer (classified as OL) over medium to coarse grained sand. The top layer may have some petroleum residue present due to a January 1988 oil spill. Preliminary estimates of the bottom densities are computed as greater than 2.0 g/cm³. This organic silt layer is too thin in some cases to be resolved with the 'pinger' system but the bottom characteristics of the material may greatly affect the reflection coefficients and bottom density estimates. Therefore, it is not known whether the presence of possible petroleum residue is promoting the high reflection amplitudes or the signatures are characteristic of the sediment material.

Area MR-3. Area MR-3 is a small zone along the right descending riverbank at approximately RM 24.6 (see Figure 14). The seismic reflection signals, although the signal amplitude values are slightly less, and side scan images for this area are similar to those of Area MR-2. A reflection horizon is detected at a depth of 2 to 3 ft below the bottom surface and correlates well with Core D-01 which indicates approximately two feet of sand over silt. The core information also indicates a thin bottom layer of organic silt with trace petroleum residue. Preliminary bottom density estimates are approximately 1.8 g/cm³.

Area MR-4. The location of Area MR-4 is between RM 24.3 and RM 24.6 as presented in Figure 14. Preliminary estimates of the bottom densities are highly variable as evidenced from the pockets of differing reflection signatures at or near the bottom surface. Bottom images from the

side scan sonar indicate a bottom having a moderate to coarse texture indicative of fine sands to gravels. Possible reflection horizons are noted along survey line PP2. The cores collected within this zone (D-02 and D-03) also demonstrate sediment variability by detecting combinations of sand and silt in the near-surface.

Area MR-5. Area MR-5 is located between RM 24.6 and RM 25.0 as illustrated in Figures 14 and 16. Acoustic penetration into the subbottom is limited to less than 10 ft over most of the area although intermittent layering is detected within the upper two feet of sediment. The characteristics of the bottom sediments are variable and range from silts to gravels. Preliminary bottom density estimates range from 1.8 to 2.1 g/cm³. One area of good acoustic penetration is detected along survey line PP1 (files 0122-0125) near a pipeline crossing where the competent river bottom sediments have been disturbed. Otherwise, signal attenuation limits the resolution of any subbottom layering. A representative seismic reflection record (survey PP1, files 0110-0130) and side scan sonar image (survey PP1, fix points 0540-0810) for this area near RM 24.8 are presented in Figures 17 and 18, respectively. Visual description of the subbottom material from nearby cores indicate that the sediments are comprised of silty to gravelly sands.

Area MR-6. The region indicated in Figures 16 and 19 as Area MR-6 extends along the left-descending riverbank between RM 24.8 and RM 26.0 until it crosses the channel centerline and continues to RM 26.5. Good acoustic penetration is achieved along this reach and a well-defined, multi-layer environment is detected (see Diagrams F-1 and F-8). The top layer is approximately 1 to 4 ft thick and thins towards the right descending riverbank. Although the acoustic signatures are fairly consistent, intermittent pockets of higher amplitude signals representing more competent sediments are also detected. The material on the river bottom surface is interpreted as being due to shoaling. A core taken in the channel centerline at RM 26.0 (see Table 4) indicates at least one foot of fine to coarse grained sand with some gravel underlain by layers of silty clay and gravelly sand. A seismic record along survey line PP1 (files 0260-0290) at this location, near RM 25.9, is presented in Figure 20. The side scan sonar records for this reach also note the likelihood of fine-grained sediments interspersed along the river bottom as well as an irregular bottom surface indicative of shoaling. Scour or drag lines from passing barges are also detected. A portion of the side scan record from survey line PP1 (fix points 1500-1680) illustrates these features in Figure 21. The data in the figure correspond to the seismic data in Figure 20. Incorporating river bottom sample information and geoacoustic modeling, preliminary density estimates of the bottom sediments range from 1.8 to 2.1 g/cm³. The layer detected 2 to 4 ft below the river bottom (see survey line PP2, files 0160-0330) is more consistent in composition and is interpreted as exhibiting higher computed density values.

Area MR-7. Area MR-7 parallels Area MR-6 along the outside of the river bend (right descending bank) between RM 24.8 and RM 26.3 as shown

in Figures 16 and 19. Interpretation of the seismic data collected in this area indicated bottom amplitudes characteristic of sands and gravel and no subbottom interfaces implying the sediment composition is similar throughout the depth of investigation. The side scan sonar interpretation displays a more coarse sediment texture along the right descending river bank (see the left side of Figure 21) which is also indicative of sand and gravel. Preliminary bottom density values are estimated as being greater than 1.8 g/cm^3 .

Area MR-8. Area MR-8 extends between RM 25.9 and RM 26.6 as shown in Figures 16 and 19. This area is a continuation of Area MR-6 along the left descending river bank except that the detection of subbottom interfaces diminishes and reflection signatures along the bottom surface become more variable. The lack of subbottom interfaces implies similar characteristics of the sediment components at depth. The variability of the bottom signals is due to the distinct zones of silt/sand material versus sand/gravel sediments. This variability of the bottom surface material is reflected in the preliminary density estimates which range from 1.5 to 2.0 g/cm^3 . A zone of strong reflection signatures is detected at the bottom surface along survey line PP4b (files 0282-0303). These signatures may be due to organics (petroleum residues, decaying material, etc.), cemented sediments, slag, or other competent reflectors. However, this zone is barely noticeable along the adjacent seismic line PP2.

Area MR-9. Area MR-9 is situated at the channel crossing between two bends of the river as shown in Figure 19. In terms of river miles, this region extends from RM 26.4 to RM 27.4. Good acoustic penetration was obtained with the 'pinger' system along this reach with reflection horizons discernable to depths exceeding 10 ft. The most distinct interface undulates between 1 and 7 ft below the river bottom as indicated in Figure 22 and illustrated in Diagram F-2 in Appendix F. This data was collected along survey PP1 (files 0390-0420) near RM 26.9. No core information is available in this area. However, interpolating the core information from Core #2 (located at RM 26.0), the near-surface material comprising the upper layer (layer 1) is likely sands mixed with silts and clays overlying gravelly sand (layer 2). Preliminary bottom density estimates range from 1.6 to 1.9 g/cm^3 and, overall, are slightly less than those determined in Area MR-6. The estimated density of the material defining the second layer, as determined from calculations performed where this layer exists at the bottom surface, is typically greater than 2.0 g/cm^3 and indicative of coarse sand and gravel (see Table 1). Closer to the right descending riverbank, the bottom surface topography becomes more irregular due to the presence of sediment waves and possible shoaling as indicated in the side scan sonar data.

Area MR-10. The river bottom topography in this area between RM 26.7 and RM 27.3 (see Figure 19), as determined from the seismic reflection and side scan sonar records, is irregular. The side scan sonar data collected along survey line PP1 (fix points 2670-2880) near RM 27.2 illustrates mounds or

ridges of coarse textured material indicative of materials comprised of gravels or rocks (see Figure 23). Sediment density estimation in this area is difficult.

Area MR-11. Area MR-11 is an oddly shaped region trending from the channel centerline to the right descending riverbank between RM 27.1 and RM 27.7. The area is located as shown in Figure 19. Good acoustic penetration is achieved to depths exceeding ten feet below the river bottom but the acoustic impedance contrast between the layers detected in Area MR-9 lessens. A faint layer is detected at an approximate depth of 8 ft below the river bottom (see Diagram F-2). Unfortunately, no core information is available in this portion of the river to assist in identifying the subbottom sediments. The less distinct impedance contrasts between layers suggests that the sediment units have a similar material composition such as a silt/sand/gravel matrix. River bottom images from the side scan sonar continue to indicate the presence of sediment waves along the right descending riverbank as shown in Figure 23. Initial bottom sediment density estimates are highly variable and gradually increase in value in the upstream direction.

Area MR-12. A large area of high amplitude reflection signatures was collected beginning near RM 27.3 and extending upstream for two miles (see Figures 19 and 24). Acoustic penetration is limited to approximately five feet and no subbottom interfaces are detected in the channel or along the left descending riverbank. Reflection signatures of this nature are typical of coarse-grained sands, gravels (rock fragments, coal, slag), or compacted sediments. No bottom samples or core information are available in this area. The side scan sonar image (survey line PP1, fix points 3450-3660) and seismic amplitude record (survey line PP1, files 0560-0590) collected near RM 28.2 and presented in Figures 25 and 26, respectively, are representative of the data acquired in this area. Preliminary density estimates of the competent bottom material are greater than 2.0 g/cm^3 and indicative of gravel material. The reflection amplitudes and density estimates are fairly consistent along this section of the river with only a few isolated zones of variability. Along the right descending riverbank (refer to survey line PP5), an interface is detected approximately 2 to 4 ft below the bottom surface as illustrated in Diagram F-29. The upper sediments, likely fine-grained material, are deposited through shoaling along the point bar. Referring to the left side of the side scan image shown in Figure 25, sediment waves are easily detected along this riverbank. The underlying material is the same as that found in the middle of the channel. Two sets of side scan sonar anomalies are detected in this area as indicated in Figure 25. A rectangular anomaly is oriented parallel to the channel centerline and has interpreted dimensions of 8 ft wide \times 70 ft long. The anomaly, which also has some relief above the bottom surface, is located at approximately E:1349425, N:336600. The other anomalous area, located just upstream of the rectangular anomaly, consists of two sets of four circular shapes arranged in a diamond configuration (see Figure 25). Each circular shape is approximately 25 ft in diameter. These features were not detected on the seismic amplitude recorders. It should be noted that because of the following factors: (1) much lower operating frequencies, (2) much longer

acoustic pulse lengths, and (3) lower data acquisition rates than the side scan sonar, the seismic equipment is less able to resolve small anomalous features at or near the bottom surface. The seismic systems are able to detect submerged objects in the bottom and subbottom sediments if the object is of sufficient size.

Area MR-13. Area MR-13 is a small zone located along the left descending riverbank between RM 28.5 and RM 28.7 (see Figures 19 and 24). Low amplitude seismic signatures are detected along the bottom surface and are indicative of fluid mud or clay material. Preliminary density estimates of this material, ranging in thickness from 1 to 2 ft, are less than 1.3 g/cm^3 . Reflection signatures of the underlying material are characteristic of the sand and gravel sediment detected in Area MR-12. The side scan sonar also detects these soft sediments.

Area MR-14. Area MR-14 is small zone located upstream of Area MR-13 between RM 28.8 and RM 28.9 as shown in Figure 24. However, the seismic signatures reflected from the river bottom in this area have uncharacteristically high amplitudes indicative of cemented sediments, slag, rock, or gaseous organic material. This zone is not detected along the adjacent seismic line PP2. No subbottom interpretations can be made in this area unless detailed core information is available.

Area MR-15. Extending along the left descending riverbank, Area MR-15 is situated between RM 29.2 and RM 30.1 as shown in Figure 24. High amplitude seismic reflection signatures from the bottom and subbottom material are detected and are characteristically similar to those recorded in Area MR-12. The differences, albeit subtle, between this area and Area MR-12 are that the reflection records illustrate more variability in the bottom and subbottom signatures. The reflection amplitudes are representative of coarse-grained sands, gravels, or compacted sediments material. Analysis of Sample #3 (see Table 4) collected at RM 30.0 correlates with the seismic interpretation by revealing gravelly sand along the bottom surface. Average initial bottom density estimates are approximately 2.0 g/cm^3 and highly variable; also indicative of sand and gravel material (see Table 1). No subbottom layering is detected but pockets of more dense material, representative of loose rock or gravel zones, do appear intermittently in the subbottom.

Area MR-16. Area MR-16, beginning at RM 29.1, parallels Area MR-15 along the right descending riverbank to RM 30.0 at which point this region begins to follow the left descending riverbank up to RM 30.5 (see Figures 24 and 27). High amplitude seismic reflection data is recorded in this zone with numerous pockets of higher and lower amplitude data. Possible layering is detected 2 to 4 ft below the bottom surface near RM 29.7 as indicated in the reflection record (survey PP5, files 0600-0630) displayed in Figure 28. However, the layer is discontinuous in nature. A bottom sample collected along the channel centerline at RM 30.0 (see Table 4) indicates gravelly sand at a depth of 1.5 ft below the bottom overlying silty sand sampled at a depth of

five feet. Silty gravelly sand is sampled at a depth of 10 ft. A schematic of the core log is superimposed over the seismic record (survey PP1, files 0790-0810) at this location as shown in Figure 29. The thickness of the upper material thins towards the center of the navigable channel. River bottom images provided by the side scan sonar display a moderate to coarse grained texture indicative of sands and gravel. Preliminary bottom density estimates are highly variable but typically range from 1.8 to 2.1 g/cm³. Mounds of sediment are also detected near each the bank line.

Area MR-17. This region is located along the right descending riverbank between RM 30.1 and RM 30.5 as shown in Figures 24 and 27. Large mounds of sediment material are detected in this area as recorded with the 'pinger' system along survey lines PP3 and PP5 and imaged with the side scan sonar. Some of these mounds may exceed a height of five feet. The bottom reflections have high amplitudes indicative of competent bottom material; likely the gravelly sand sediment detected in Area MR-16. No subbottom interfaces are detected because of signal attenuation. Preliminary bottom density estimates are approximately 2.0 g/cm³.

Area MR-18. Figure 27 illustrates the location of the two zones labeled Area MR-18. These zones are positioned along the left descending riverbank between RM 30.9 and RM 31.0 and RM 31.3 and RM 31.5. The recorded signatures of the seismic reflection data are characteristic of those detected in Area MR-14. The very high amplitude reflection signals may be due to cemented sediments, slag, gaseous organic sediments, or other acoustically reflective material. The seismic data and subsequent density estimates are uncharacteristic of natural sediment material. The side scan sonar displays no anomalous conditions in these areas.

Area MR-19. Area MR-19 is located between RM 30.3 and RM 31.7 as indicated in Figure 27. The seismic reflection data detect little to no layering along this reach but numerous zones having higher reflection signatures are recorded along the bottom surface. A portion of the seismic data collected along survey line PP2 (files 1190-1220) near RM 31.2 is presented in Figure 30 and is representative of the seismic signatures in this area. With the numerous differing zones detected at the bottom surface, the preliminary density estimates are also highly variable from one file to the next. Estimates range from 1.8 to 2.1 g/cm³ and indicative of sands and gravels (see Table 1). The side scan sonar image of the river bottom has a moderate to coarse texture which is also indicative of sands and gravels.

Area MR-20. The location of Area MR-20 is shown in Figures 27 and 31. This area extends from bank-to-bank between RM 31.7 and RM 32.2 and, beyond RM 32.2, along the right descending riverbank up to RM 33.6. The characteristic reflection signatures from the bottom sediments are similar to those in Area MR-19 except that the overall amplitudes are slightly diminished; indicative of more silt or fine sands in the sediment matrix. This in turn relates to lower preliminary bottom density estimates. Density estimates

are highly variable and range from 1.6 to 2.0 g/cm³. Side scan sonar images of the bottom, collected along survey line PP1 (fix points 7200-7410) near RM 33.0 and displayed in Figure 32, indicate a moderate texture with intermittent areas having a more coarse texture. These images are typical of fine or silty sand with some gravel. The seismic reflection records also illustrate zones of more dense material and possible layering at depths of 1 to 4 ft below the bottom surface. Core samples #4 and #5, collected along the channel centerline at RM 32.0 and RM 32.5, respectively (see Table 4), indicate zones of well to poorly graded sandy gravel, gravelly sand, and gravelly clayey sand to depths greater than seven feet. The core at RM 32.5 also indicates a sandy clay sample at a depth of nine feet. The detected pockets or layers thin towards the left descending riverbank. It is also interesting to note the linear ridges and ellipsoidal feature along the channel bottom as depicted in the side scan record (Figure 32). These ridges or scour marks are likely created by passing barges in the narrow and shallow waterway.

Area MR-21. Representing the river along the left descending riverbank and located adjacent to Area MR-20, Area MR-21 is shown in Figures 27 and 31 between RM 32.2 and RM 33.4. Little to no layering is detected within the subbottom sediments but zones having higher reflection coefficients are computed throughout this area. These detected pockets indicate the bottom sediments are variable in composition which relates in turn to the variability of the bottom density estimates. Estimated density values vary between 1.8 and 2.1 g/cm³. The side scan sonar image of this area presented on the right side of Figure 32 has a moderate to coarse texture indicative of sand and gravel.

Area MR-22. Area MR-22 is located between RM 33.3 and RM 34.2 as presented in Figure 31. Good acoustic penetration in this area highlights the detection of multiple layers within the subbottom. The layers are better distinguished near the center of the channel and thin or diminish towards each riverbank. The depth to layers varies from 1 to 8 ft below the bottom surface as illustrated in Diagrams F-4 and F-11 for survey lines PP1 and PP2, respectively. Two of the four cores collected in this area, cores D-1 and #6 (outlined in Tables 3 and 4), are schematically displayed in Figure 33 on a portion of the seismic amplitude record collected along survey line PP2 (files 1620-1650) at RM 34.0. Both core locations indicate 5.5 to 6 ft of sandy gravel or sand with gravel overlying a layer of gravelly sand. The depth of the interface in each core correlates well with that detected along the seismic record. Figure 33 also illustrates highly variable seismic amplitudes along the bottom surface from pockets and zones of more dense material. The overall amplitudes, however, are much less when compared to those signals acquired in previous areas such as Area MR-19. Preliminary bottom density are highly variable and range from 1.4 to 1.9 g/cm³. Density values in this range may indicate that increased amounts of silts or fine sands may be present in the sediment matrix or the bottom sediments are more unconsolidated. Referring to Core R-2 near RM 33.6 (see Table 3), a layer of silt material is identified at the bottom surface. The lowest amplitude signals (lowest bottom density

estimates) recorded are primarily detected within the region labeled Area MR-22a as shown in Figure 31. Region MR-22a is located between RM 33.6 and RM 33.8.

Area MR-23. Area MR-23, shown in Figures 31 and 34 between RM 34.1 and RM 35.0, is positioned along the left descending riverbank and likely a continuation of Area MR-22. The distinction between this region and Area MR-22 is that the recorded seismic signals have higher amplitudes which in turn relates to higher bottom density estimates. Estimated bottom density values are approximately 1.6 g/cm^3 with little variability. Subbottom layers and/or zones of more dense material, probably gravelly sand as detected in Area MR-22, are detected at depths of 1 to 8 ft below the bottom surface. These zones tend to diminish or thin near the channel centerline. No core information is available in this area. Side scan images of the bottom indicate possible shoaling and low amplitude sediment waves within this area. The imaged bottom sediments have a moderate texture indicative of silts and sands.

Area MR-24. Area MR-24 is adjacent to Area MR-23 beginning at RM 34.1 and extending along the right descending riverbank to RM 35.1 (see Figures 31 and 34). Seismic signatures recorded within this area have consistent peak amplitude values. However, intermittent and isolated pockets of more dense material, likely gravelly sediment zones, having higher amplitude reflections are detected along the bottom surface. Preliminary bottom density estimates are approximately 1.7 g/cm^3 . Side scan sonar interpretations indicate moderate to coarse textured bottom images characteristic of sand mixed with gravel. The seismic reflection data indicate little to no subbottom layering within the near-surface material implying that the acoustic impedance values of the subbottom sediments are similar and no reflections are produced. The side scan images also illustrate drag marks along the edges of the navigable channel.

Area MR-25. Area MR-25 is situated along the left descending riverbank between RM 35.4 and RM 35.9 as shown in Figure 34. Very high amplitude bottom reflection signals are recorded in this area and produce the seismic record, collected along survey line PP2 (files 2140-2170) near RM 35.7, shown in Figure 35. The signatures are typical of those reflections recorded from cemented sediments, rock, slag, or organically-rich materials. Limited acoustic penetration is attained with both the 'pinger' and 'boomer' systems and no layering is detected in the subbottom amongst the numerous multiple reflections. Bottom density estimates are unrealistically high and no core information exists at this time for verification or clarification.

Area MR-26. Area MR-26, outlined in Figure 34, begins near RM 35.1 and extends 1.1 miles to RM 36.2. Preliminary bottom density estimates along this reach of the river are variable and range from 1.8 to 2.1 g/cm^3 , indicative of sands and gravels. Changes in material characteristics as determined from the reflection signatures are found in broad zones along the river

bottom rather than in small pockets as detected earlier. In general, though, amplitudes of the seismic reflection data increase near Area MR-25 where uncharacteristically high bottom reflection signatures are noted. Side scan sonar images (survey PP1, fix points 9510-9720) collected near RM 35.7 are shown in Figure 36 and denote a coarse texture indicative of gravels mixed with sand. Signatures denoting reflection horizons within the subbottom are infrequent. However, one such area is detected along survey line PP2 (files 2060-2090) but it is uncertain whether these interfaces represent any continuous subbottom layering. The side scan sonar also detects numerous small rectangular anomalies, as noted in Figure 36, along the channel bottom which may be indicative of debris such as pipes, lumber, poles, or submerged trees.

Area MR-27. Area MR-27 extends from RM 36.1 to RM 37.1 before tapering towards and following the left descending riverbank to RM 37.7 as illustrated in Figures 34 and 37. The amplitudes of the recorded seismic signatures are slightly variable over this section of the river as displayed in Figure 38 for data collected along survey line PP3 (files 1460-1490) near RM 36.4. This in turn promotes variable bottom density estimates and material type classifications as well. Initial density estimates are generally less than those computed in Area MR-26 and range from 1.6 to 1.9 g/cm³ with an average value of approximately 1.7 g/cm³. This range of values may imply greater percentages of silt and fine sand material in the bottom sediment matrix. A representative side scan sonar image of the river bottom (see Figure 39), collected along survey line PP1 (fix points 560-800) near RM 37.0, indicates a coarse textured bottom surface along the centerline and right descending riverbank. Nearer the left descending riverbank, the bottom texture is more smooth and sediments waves can be distinguished. Sediment interfaces are interpreted along portions of survey line PP3, see Figure 38, at depths of 1 to 3 ft below the bottom surface. The density estimates of the deeper material are greater than that of the bottom sediments; indicative of coarse-grained or gravelly sediments. These layers become more discontinuous towards the left descending bankline. The nearest core is Core #7 along the channel centerline at RM 37.5. Referring to the core summary in Table 4, the near-surface sediments are characterized by gravelly sand and well-graded sands and gravel. Sand is detected at a depth of 6.5 ft and overlies a clayey gravelly sand sampled at a depth of nine feet.

Area MR-28. The river bottom and subbottom sediments near the right descending riverbank between RM 37.1 and RM 38.8 are categorized under the interpretation for Area MR-28. The outline of this area is presented in Figures 37 and 40. Area MR-28 is very similar to the geophysical interpretation of Area MR-27. The average bottom density estimate is slightly higher than in Area MR-27 at 1.8 g/cm³ and pockets or zones of more dense material are detected along the bottom surface. Acquired seismic data representative of this area are presented in Figure 41. The data was collected along survey line PP3 (files 1670-1700) near RM 38.1. Indications of possible subbottom layering or zones of more dense material at depth are detected along some

segments of the survey lines in this area. Insitu sediment information is provided by Cores #7 and #8 (see Table 4) drilled along the channel centerline at RM 37.5 and RM 38.5, respectively. The analysis of Core #7 is listed in the discussion of Area MR-27. Core #8 detects sandy gravel at a depth of 10 ft.

Area MR-29. Area MR-29 extends from RM 38.0 to RM 39.5 as shown in Figures 37 and 40. Bottom reflection amplitude values are highly variable indicating constantly changing bottom conditions. Zones and pockets of more dense material are visible on the amplitude records and at depths of 1 to 4 ft along each bankline. These zones at depth are discontinuous in areas and, therefore, it is uncertain whether or not this represents distinct subbottom layering or indications of shoaling. The nearest core information is that of Core #8 drilled at RM 38.5 and outlined in Table 4. Estimated bottom density values range from 1.4 to 1.9 g/cm³, indicative of silts and sands, with an average value of approximately 1.6 g/cm³. The higher amplitude zones are likely due to more coarse-grained materials such as gravels. The lower density values are primarily estimated between RM 39.0 and RM 39.4. Side scan sonar images indicate a moderate to coarse texture along the centerline of the channel, indicative of sandy sediments, and less coarse textures along each riverbank. Small sediment waves are indicated near the right descending riverbank and drag lines or scour marks are easily visible.

Area MR-30. Area MR-30 is located between RM 39.4 and RM 39.6 as shown in Figure 40. This area is characterized by very high amplitude bottom reflection signals which are typical of those reflections recorded from cemented sediments, rock, or organic materials. Limited acoustic penetration is attained with the high resolution seismic reflection systems and bottom density estimates are unrealistically high. This material is overlain by a thin layer of less competent sediments, possibly silts or silty sands, along the right side of the channel. No core information is available in this area for material clarification.

Area MR-31. Area MR-31 is situated along the outside of the riverbend (left descending riverbank) between RM 39.5 and RM 40.7 as displayed in Figure 40. No distinct sediment interfaces are detected in the subbottom material with the 'pinger' system although numerous small pockets and zones characterized by higher reflection amplitudes are recorded. An example of these types of acoustic signatures are illustrated in Figure 42 for the data collected along survey line PP5 (files 1580-1610) near RM 40.2. The variable bottom signatures are reflected in the broad range of density estimates which range from 1.5 to 1.9 g/cm³; representative of silty to fine sand with intermittent gravel zones. Sonar images of the riverbed along survey line PP1 (fix points 3110-3380) near RM 40.3, see Figure 43, indicate numerous drag marks and scour lines along the perimeter of the navigable channel. Sediment waves are also imaged along the right descending riverbank.

Area MR-32. Referring to Figure 40, Area MR-32 is shown along the right descending riverbank between RM 39.6 and RM 40.1. Sonar images of

the riverbed indicate a more convoluted bottom and the presence of sediment waves near the navigable channel. This correlates with the reflection signatures acquired along survey lines PP3 and PP5 which illustrate an irregular bottom and distinct subbottom layering. The overlying material, consisting of silts or unconsolidated sands, is approximately 1 to 4 ft thick (see Diagrams F-21, F-33, and F-34) and probably the result of shoaling. The thickness of this material diminishes towards the channel centerline. The bottom characteristics as well as the estimated bottom densities are highly variable with estimated densities averaging 1.6 g/cm^3 . The underlying material has higher amplitude reflection signatures and is representative of gravelly sediments. No core information is available in this area.

Area MR-33. Area MR-33 covers the channel centerline and right descending riverbank between RM 40.4 and RM 41.2 as shown in Figure 40. Seismic reflection amplitudes and bottom density estimates are highly variable in this area; indicative of constantly changing sediment characteristics. Bottom density estimates vary from 1.4 to 2.0 g/cm^3 , representative of sediments ranging from silts to gravels, with average value of 1.7 g/cm^3 . Discontinuous pockets and zones of more dense material, zones having higher amplitude reflection signatures, are detected at depths of 1 to 3 ft below the bottom surface. Indications of possible layering appear near the central portion of the area as recorded along survey line PP3 (files 1960-1990) near RM 40.8 and presented in Figure 44. The unconsolidated and less dense surface sediments are likely due to shoaling. Side scan sonar images of the river bottom, as well as the seismic reflection data (see Figure 44), indicate highly variable bottom signatures due to the interpreted uneven and irregular bottom topography. Numerous drag lines and scour marks, likely caused by barge traffic, are imaged. Near the channel centerline, the image texture is moderate to coarse and indicative of sands and gravels. Core #9 was drilled to a depth of 10 ft at RM 41.0 along the channel centerline (see Table 4). Gravelly sand is detected at depths of 1.0 and 5.0 ft below the bottom surface with clayey sand sampled at a depth of 10.0 ft.

Area MR-34. Area MR-34 is located at the upper end of the survey between RM 41.2 and RM 41.3 and just downstream of Lock and Dam 4 as shown in Figure 40. The seismic reflection data collected have high bottom reflection amplitudes indicative of competent bottom sediments. Cores collected near Lock 4 (see Tables 3 and 4) indicate sands, gravels, and rock fragments within the near-surface material. Bottom density estimates derived from the core information and data in Table 1 range from 1.7 to 2.0 g/cm^3 . In the subbottom sediments, zones of more dense material are detected within two feet of the river bottom. It is unknown whether these zones are indicative of layering or not because of the discontinuous nature of the reflection horizons. Side scan sonar images indicate a moderate to coarse textured bottom image representative of sands and gravels. Numerous drag marks are also detected.

Area MR-35. No seismic data was collected in this area between RM 40.7 and RM 41.3 (see Figure 40) due to barge traffic on the river, tows waiting to lock upstream, and shallow water. Images of the river bottom from the side scan sonar display a moderate texture, although variable, with zones of more coarse texture. These images likely represent silts and sands with areas of gravel. Numerous drag marks and scour lines are also present.

5 Project Summary

A high-resolution, seismic reflection and side scan sonar survey was performed in Pool 3 of the Monongahela River, Pennsylvania. This portion of the investigation, Report 1, is intended to delineate the subbottom sediment interfaces, provide an interpretation of the riverine sediments with correlation to available core information, and provide preliminary density estimates of the bottom sediments. Spatial relationships for bottom and subbottom sediments interpreted as having similar acoustic signatures are presented on survey maps of the project area. Categorical grouping and classification of portions of the river is completed through the use of the seismic amplitude records illustrating the bottom and subbottom acoustic signatures, side scan sonar images of the river bottom, and preliminary density estimates of the bottom sediments. Interpreted results are also presented in profile line form to illustrate the measured depth to the river bottom surface and depths to interpreted sediment interfaces along each survey line. All of the interpreted results are referenced to the recorded positioning information.

Seismic reflection signatures recorded along the Monongahela River indicate that, over large areas of the river bottom, no distinct sediment interfaces were recorded. These areas are typically located along the outside of river bends or in the channel crossings between RM 25 and RM 36. The lack of detected reflection horizons may be due to the following factors: no sediment layers present, sediment facies having similar acoustic impedances and thereby producing no reflections, or layering is too thin to be resolved. The acoustic nature of the bottom sediments, however, is moderately to highly variable with pockets of more competent material, such as gravel or rock fragments, detected along or just below the bottom surface. Preliminary estimates of the sediment density range from 1.7 to 2.1 g/cm³.

Discontinuous layering was interpreted from the seismic reflection data along the inside of the river bends on the lower part of Pool 3 and along most of the river between RM 36 and RM 41. The 'layer' is typically detected approximately 1 to 4 ft below the bottom surface and formed by a series of pockets or zones of competent, more dense sediment material. Interpretation of the side scan sonar data in these areas typically reveal sediment waves along the bottom surface which is indicative of areas of shoaling and sediment deposition. Preliminary bottom density estimates are highly variable with

values ranging from 1.8 to 2.1 g/cm³ along the lower half of the project area. Upstream of RM 31, bottom surface densities tend to gradually decrease towards Lock and Dam 4 with values ranging from 1.4 to 1.9 g/cm³.

Subbottom layers, excluding those related to areas of shoaling, are detected in primarily two locations along the length of the project area. The first area is located between RM 26.4 and RM 27.6 as described by Areas MR-9 and MR-11. Multiple reflection horizons are interpreted to depths exceeding 10 ft with the most distinct interface undulating between 1 and 7 ft below the river bottom. However, the acoustic impedance contrast between layers lessens in the upstream direction thereby decreasing the resolution of the reflection horizons. Preliminary bottom density estimates range from 1.6 to 1.9 g/cm³ and are representative of sands and silty sands mixed with gravels. The density of the material comprising the second layer is more dense as determined from calculations performed where this layer exists at the bottom surface. These density estimates are typically greater than 2.0 g/cm³; indicative of gravelly material.

Multiple reflection horizons are also distinguished between RM 33.3 and RM 34.2 (see Area MR-22) near the center of the channel. The depth to layers varies from 1 to 8 ft below the bottom surface and thins or diminishes towards each riverbank. Two cores in this area correlate well with the acoustic data and indicate 5.5 to 6 ft of sandy gravel or sand with gravel overlying a layer of gravelly sand. Preliminary bottom density calculations are highly variable and the estimated values range from 1.4 to 1.8 g/cm³. Density values in this range may indicate that increased amounts of silts or fine sands may be present in the sediment matrix or the bottom sediments are more unconsolidated.

An area of low density bottom sediments is detected along the left descending riverbank near RM 28.6 (Area MR-13). Preliminary density estimates of this material are less than 1.3 g/cm³ and indicative of fluid mud or soft clay material. This material is 1 to 2 ft thick. Subbottom reflection signatures are characteristic of sand and gravel material.

The interpreted seismic reflection data also indicated several areas of uncharacteristically high amplitude signals. Signals of this amplitude are typically indicative of bottom materials consisting of cemented sediments, rock, slag, or organically-rich sediments. The largest area of this nature is Area MR-25 along the left descending riverbank between RM 35.4 and RM 35.9. Other smaller regions are outlined in Areas MR-2, MR-8, MR-14, MR-18, and MR-30. It is important to note that petroleum residue from an oil spill in 1988 was detected in core samples upstream of Lock and Dam 3 near Area MR-2.

The side scan sonar provided bank-to-bank imaging of the river bottom surface in order to identify textural variations in the bottom sediments which in turn lead to general sediment classification. The objective of the sonar data

was to also identify bottom surface features such as submerged debris or pipelines. Signatures characteristic of scour marks and drag lines due to barge traffic in the shallow waterway are interpreted along the entire waterway; especially upstream of RM 31. Sand waves and shoaling are detected along the inside margins of the river with these features most clearly identified upstream of RM 27. Interpreted irregular bottom features (mounds, ridges, etc.) not due to shoaling are detected along the river margins at RM 27, RM 30.2, and RM 39.9. Areas of submerged debris and other bottom anomalies were also detected. Near RM 28.2, a rectangular anomaly approximately 70 ft long was detected near the channel centerline. Located just upstream of the rectangular anomaly are two sets of four circular shapes arranged in a diamond configuration. Each circular shape is approximately 25 ft in diameter. Numerous rectangular anomalies indicative of pipes, lumber, poles, or submerged trees are scattered between RM 35 and RM 36.

Analysis of the seismic and side scan sonar information in this first part of the investigation provides a continuous profile and general acoustic description of the bottom and subbottom sediments. Depths computed from the seismic records delineate the extent and depth of the river bottom and other reflection horizons. Sediment characteristics derived from existing cores are correlated with the acoustic data to provide a more comprehensive description of the river bottom lithology.

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Table 1 Soil Type, Impedance, and Sediment Density Relationships¹		
General Soil Type	Approximate Acoustic Impedance Range ($\times 10^2$ g/cm²sec)	Approximate Sediment Density Range (g/cm³)
Water	< 1,550	< 1.12
Watery Clay / Fluid Mud	1,550 - 1,700	1.12 - 1.20
Clay	1,700 - 2,016	1.20 - 1.33
Silty Clay	2,016 - 2,460	1.33 - 1.57
Clayey Silt	2,460 - 2,864	1.57 - 1.76
Silty Sand	2,864 - 3,052	1.76 - 1.84
Fine to Medium Sand	3,052 - 3,385	1.84 - 1.94
Medium to Coarse Sand	3,385 - 3,647	1.94 - 2.03
Gravelly Sand / Sandy Gravel	3,647 - 3,927	2.03 - 2.13
Compacted Sands / ravel Loose Rock / Rock	> 3,927	> 2.13
¹ Compiled from Hamilton and Bachman (1982) and Caulfield and Yim (1983).		

Table 2
Pool 3 Water Level Elevations, Monongahela River

Survey Line Number	Date	Pool Elevation (ft, MSL)
PP1	23 October 1994	727.4
PP2	22 October 1994	727.8
PP3	25 October 1994	727.4
PP4a	23 October 1994	727.4
PP4b	24 October 1994	727.9
PP5	24 October 1994	727.7

<p>Table 3 Summary of Borehole Information, Pool 3, Monongahela River, PA</p>
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Core	River Mile	WES Survey Location	Elevation (ft)	Layer Thickness (ft)	USCS Soil Class.	Visual Description
D-01	24.6	PP5 0060	723.3	0.3	OL	SILT, w/trace petroleum
			723.0	1.8	SP	SAND, medium grained
			721.2	7.5	ML	SILT, soft w/little clay
			713.7	1.7	SP	SAND, medium grained w/sandstone fragments
			712.0	0.5	SG	GRAVEL, w/some medium to coarse grained sand
			711.5	> 7.0	SW	SAND, fine to coarse grained w/little silt
D-02	24.6	PP1 0085	707.5	0.3	OL	SILT, w/trace sand
			707.2	4.8	SW	SAND, fine to coarse grained w/sandstone and coal fragments
			702.7	1.2	ML	SILT, w/some gravel
			701.5	6.2	SP	SAND, fine to coarse grained
			695.3	2.6	SM	SILTY SAND, w/fine sand
			692.7	2.2	ML	SILT, w/fine sand and some gravel
D-03	24.6	PP4b 0504	711.7	3.2	ML	SANDY SILT, w/fine sand and some clay
			708.5	1.0	SW	SAND, medium grained w/little silt
			707.5	1.8	GP	SANDY GRAVEL, w/little silt (max. size 0.75 in.)
			705.7	1.8	ML-CL	SILT and SILTY CLAY
			703.9	2.2	ML	SANDY SILT, w/clayey silt stringers and trace gravel
			701.7	2.5	SW	SAND, medium to coarse grained coal sand
			699.2	> 6.5	GS	GRAVELLY SAND, fine to coarse grained w/gravel
R-01	24.6	PP5 0090	712.0	1.5	--	SOIL
			710.5	3.8	SP	SAND, medium grained w/some gravel
			706.6	1.7	ML	SILT, soft w/some sand and gravel
			704.9	7.5	SP	SAND, w/occasional gravel and coarse sand
			697.4	> 4.5	SG	GRAVELLY SAND, w/little silt (organically contaminated)
R-02	24.6	PP5 0014	719.9	0.5	OL	SILT, w/some fine to coarse grained sand
			719.4	4.4	SP	SAND, medium grained w/some coarse sand
			715.0	5.4	ML	SILT, w/little fine sand
			709.6	0.7	SW	SAND, medium grained w/some sandstone fragments and gravel
			708.9	1.3	ML	SILT, w/little sandstone fragments
			707.6	> 6.3	SW	SAND, fine to coarse grained w/some gravel

(Continued)

Table 3 (Concluded)

Core	River Mile	WES Survey Location	Elevation (ft)	Layer Thickness (ft)	USCS Soil Class.	Visual Description
D-1	34.0	PP2 1650	712.8	6.0	SP	SAND, fine to coarse grained w/some coal and shale fragments
			706.8	> 13.0	SP	GRAVELLY SAND, w/coal fragments and trace silt
R-2	34.0	PP5 0984	717.5	2.0	ML	SILT, w/some fine to coarse grained sand
			715.5	6.0	SP	SAND, w/occasional gravel and trace silt
			709.5	9.0	SG	GRAVELLY SAND, w/fine to coarse grained sand
			700.5	> 2.0	GS	SANDY GRAVEL, w/fine to coarse grained sand
R-3	34.0	PP3 1170	713.3	25.8	--	No Sampling
			686.5	> 15.2	--	CLAYSTONE, thinly bedded, very soft (friable), numerous and frequent fractures
RW-09	41.5	PP2 3080	715.0	6.0	GS	SANDY GRAVEL, rounded gravel w/medium to coarse grained sand and trace coal fragments
			709.0	> 14.0	GP	SAND and GRAVEL, medium to coarse grained sand and rounded gravel w/some silt, silt decreasing with depth
RW-10	41.5	PP2 3080	715.2	> 20.0	SM-GP	SILTY SAND and GRAVEL, medium to coarse grained sand, rounded gravel, silt decreasing with depth
CF-12	41.5	PP1 2212	711.1	4.0	GM	SILTY SAND and GRAVEL, w/occasional rock fragments
			707.1	4.0	GP	SAND and GRAVEL, fine to medium grained sand w/trace rock fragments
			703.1	2.0	--	COAL FINES and ROCK FRAGMENTS, w/trace sand
			699.1	8.0	SP	SAND, fine to medium grained w/trace rock fragments, coal gravel, and clay
			693.1	> 1.0	GP	SAND and GRAVEL, fine to medium grained sand w/trace rock fragments
CF-13	41.5	PP1 2212	711.8	2.0	--	SAND and ROCK FRAGMENTS, w/trace gravel
			709.8	6.0	SM	SILTY SAND, fine grained sand w/little rock fragments
			703.8	2.0	--	LIMESTONE FRAGMENTS and SAND, fine grained sand w/some gravel
			701.8	4.0	GP	SAND and GRAVEL, fine to medium grained sand w/little rock fragments
			697.8	2.0	SP	SAND, fine to medium grained w/trace gravel, rock fragments, and coal fines
			695.8	2.0	--	ROCK FRAGMENTS and SAND, w/trace gravel

Table 4
Summary of Subbottom Sampling Information, Pool 3, Monongahela River, PA

Sample Site	River Mile	WES Survey Location	Sample Depth Below Bottom (ft)	USCS Soil Class.	Gravel (%)	Sand (%)	Fines (%)	Visual Description
1	24.0	PP1 0000	0.5	GS	25	74	1	GRAVELLY SAND
			1.5	GS	25	74	1	GRAVELLY SAND
			3.0	GP	50	49	1	SANDY GRAVEL
2	26.0	PP1 0282	1.0	SP	10	86	4	SAND, fine to coarse grained w/small gravel
			4.5	CL	--	40	60	SANDY CLAY, fine to coarse grained sand
			7.0	SP-SM	34	58	8	GRAVELLY SAND, fine to coarse grained sand w/rounded gravel
			9.8	SC	--	77	23	CLAYEY SAND, fine to coarse grained sand
3	30.0	PP1 0800	1.5	SP-SM	27	65	8	GRAVELLY SAND, fine to coarse grained sand w/angular gravel
			5.0	SM	--	87	13	SILTY SAND, fine to coarse grained sand
			10.0	SM	17	68	15	SILTY GRAVELLY SAND, w/fine subangular gravel
4	32.0	PP1 1043	1.5	GW-GM	53	40	7	SANDY GRAVEL, w/fine to coarse grained sand
			4.0	GP-GM	47	44	9	SANDY GRAVEL, w/fine to coarse grained sand
			10.0	GW-GM	56	35	9	SANDY GRAVEL, w/fine to coarse grained sand
5	32.5	PP1 1103	2.0	GW	70	26	4	SANDY GRAVEL, w/fine to coarse grained sand
			5.5	SC	17	57	26	GRAVELLY CLAYEY SAND, w/fine to coarse subangular gravel
			6.5	SP-SM	23	68	9	GRAVELLY SAND, w/fine to coarse subangular gravel
			9.0	CL	--	23	77	SANDY CLAY, w/fine to coarse grained sand
6	34.0	PP1 1294	5.5	GW	73	22	5	SANDY GRAVEL, w/fine to coarse grained sand
			10.0	SP-SM	21	70	9	GRAVELLY SAND, w/fine to coarse angular gravel
7	37.5	PP1 1722	1.0	SP-SM	45	49	6	GRAVELLY SAND, w/fine to coarse angular gravel
			4.0	GW	72	24	4	SANDY GRAVEL, w/fine to coarse grained sand
			6.5	SP-SM	--	95	5	SAND, fine to coarse grained sand
			8.0	SC	23	55	22	CLAYEY GRAVELLY SAND, w/fine to coarse angular gravel
8	38.5	PP1 1843	10.0	GP	61	36	3	SANDY GRAVEL, angular gravel w/fine to coarse grained sand
9	41.0	PP1 2164	1.0	SP-SM	46	48	6	GRAVELLY SAND, w/fine to coarse angular gravel
			5.0	SP-SM	26	69	5	GRAVELLY SAND, w/fine to coarse angular gravel
			10.0	SC	3	63	34	CLAYEY SAND, w/fine angular gravel

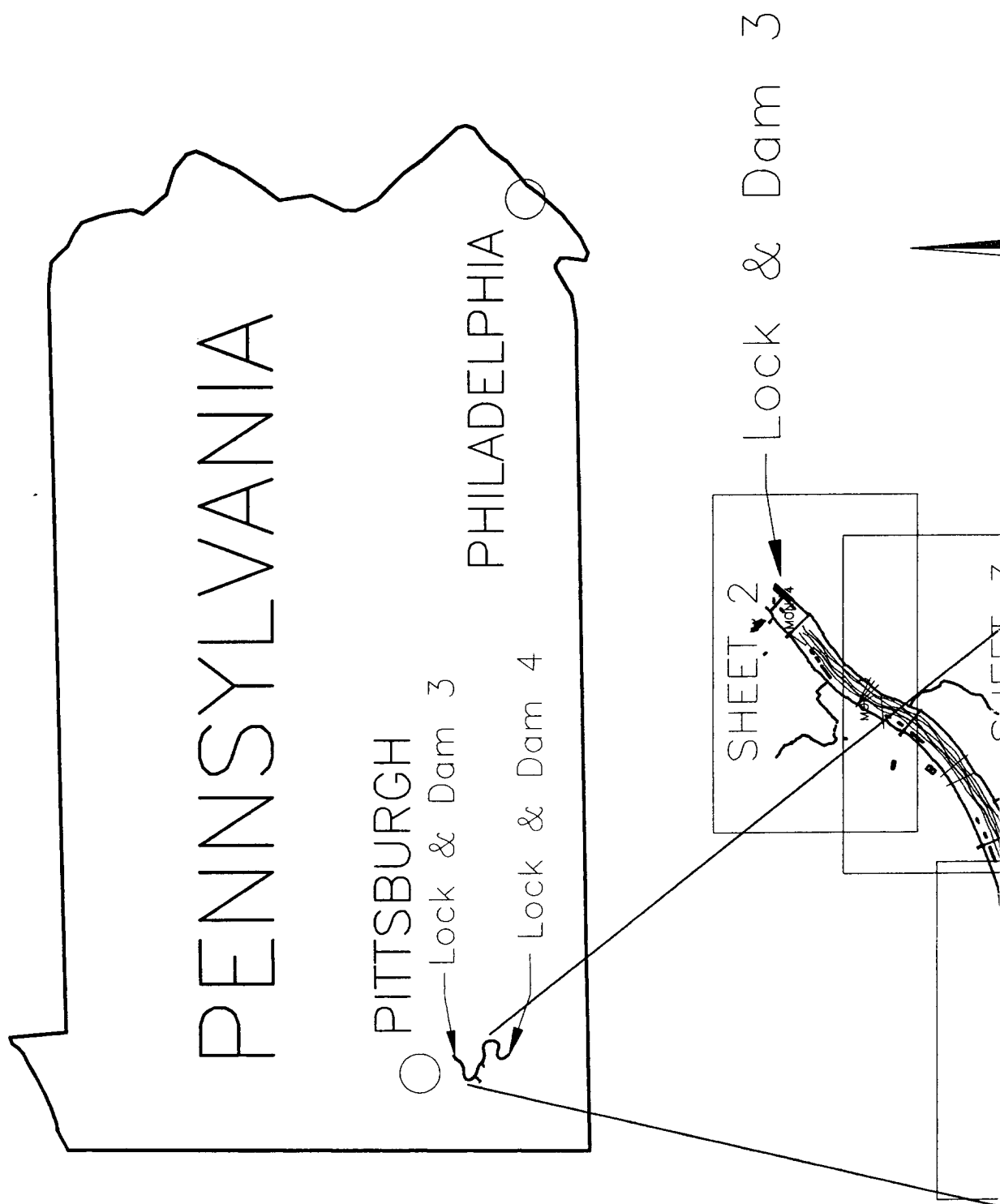
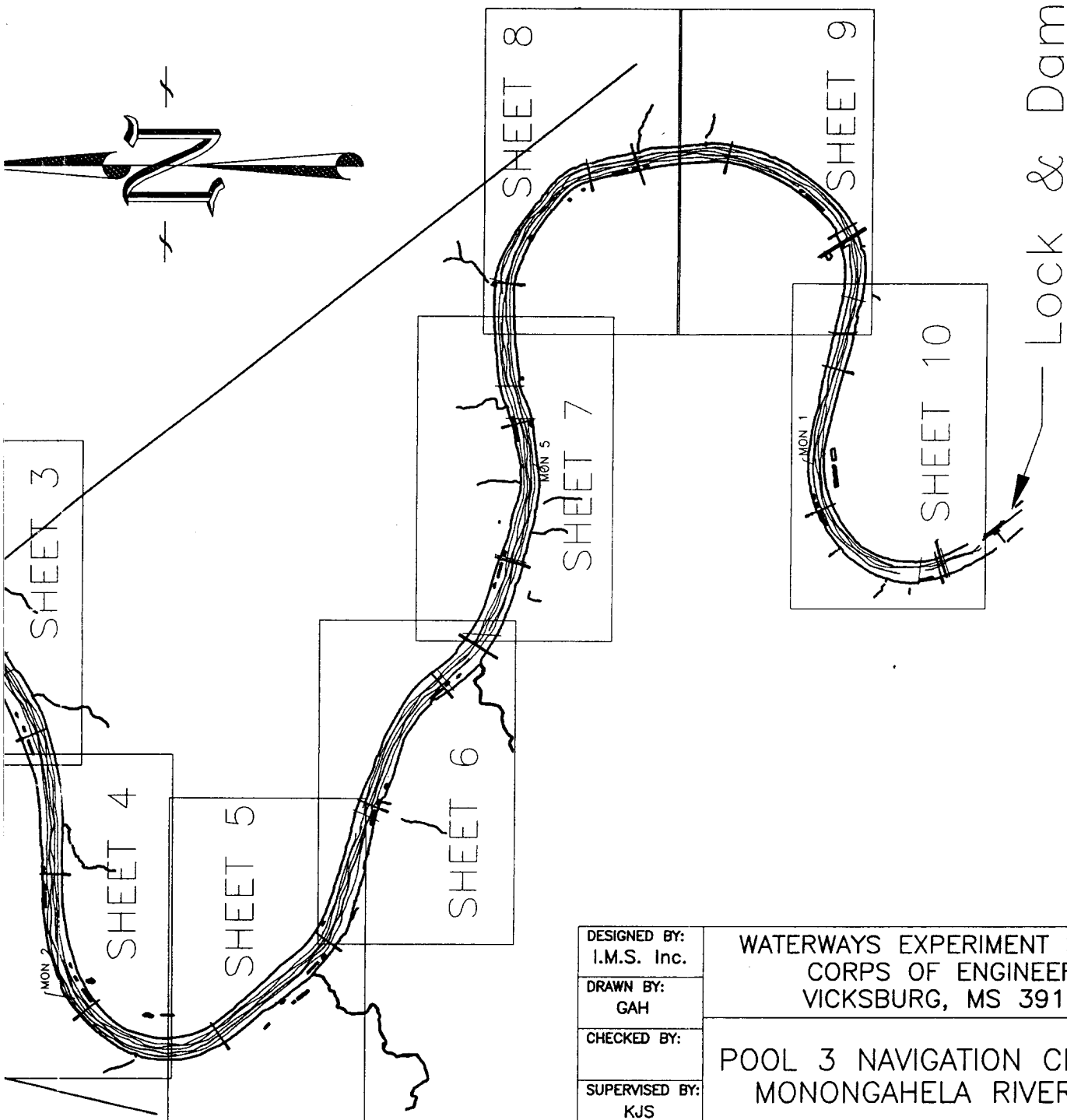


Figure 1. Location of Pool 3, Monongahela River, Pennsylvania



DESIGNED BY: I.M.S. Inc.	WATERWAYS EXPERIMENT STATION CORPS OF ENGINEERS VICKSBURG, MS 39180		
DRAWN BY: GAH			
CHECKED BY:	POOL 3 NAVIGATION CHANNEL MONONGAHELA RIVER, PA		
SUPERVISED BY: KJS			
SH.REF.NO.	SPEC.NO.	SIZE	FILE NO.
			DRAWING NO. IMS/MON/MONBASE.DWG
SCALE: 1"=5500'		DATE: 22 MARCH 1995	SHEET 1 of 10

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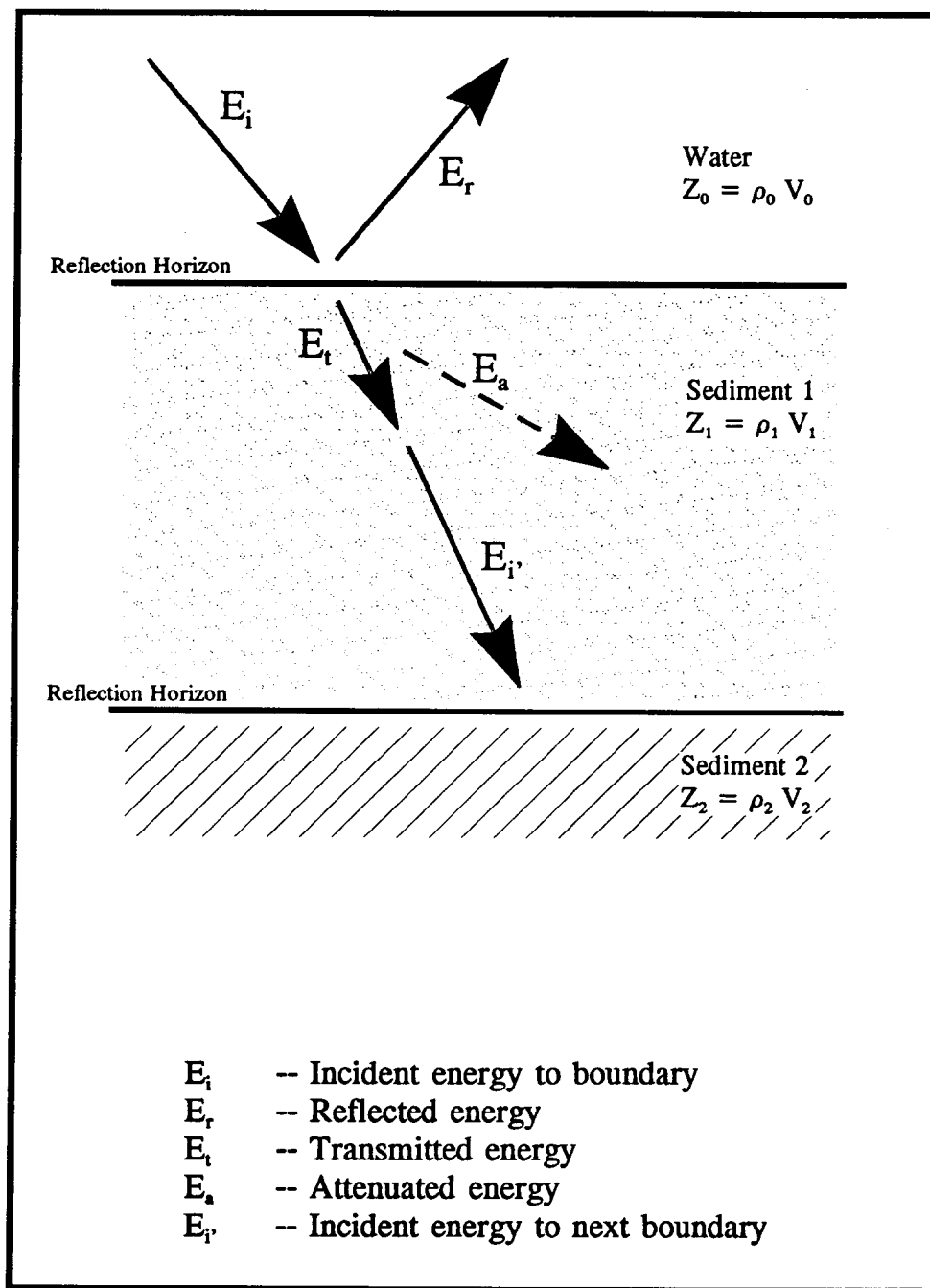


Figure 2. Ray diagram of the seismic reflection technique

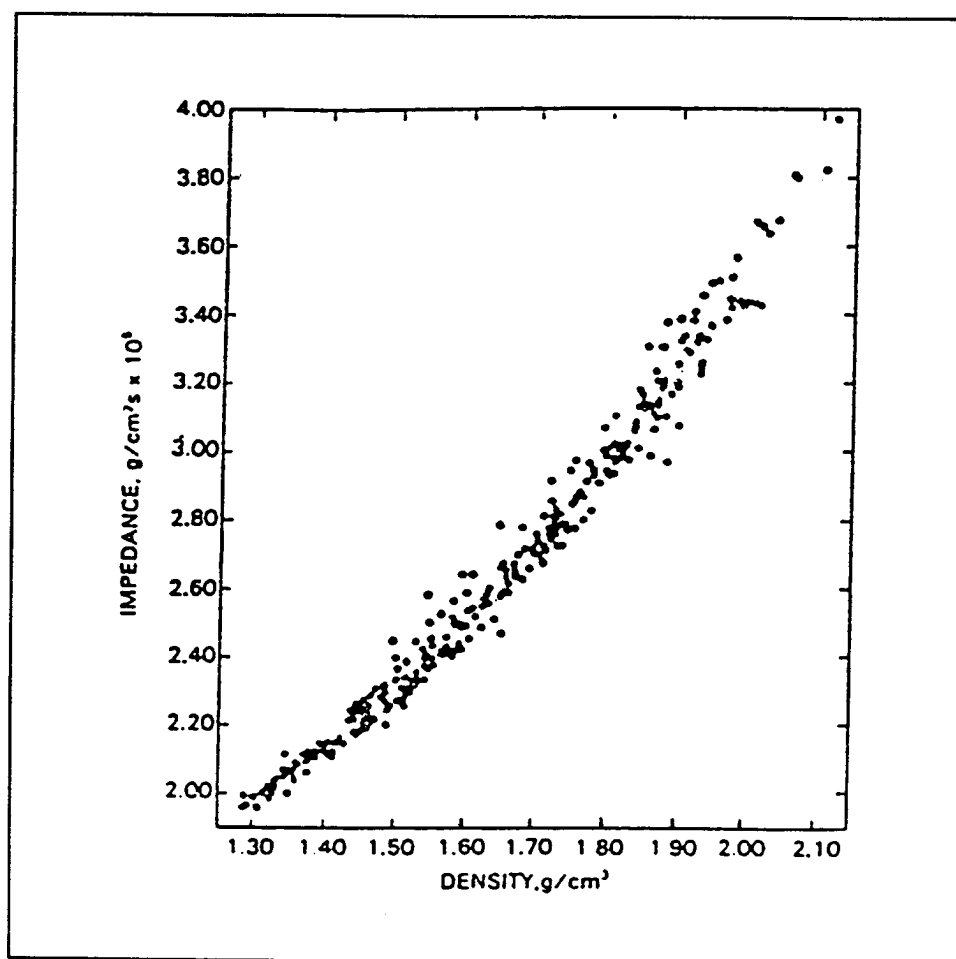


Figure 3. Acoustic impedance versus material density for ocean sediments (Hamilton and Bachman, 1982)

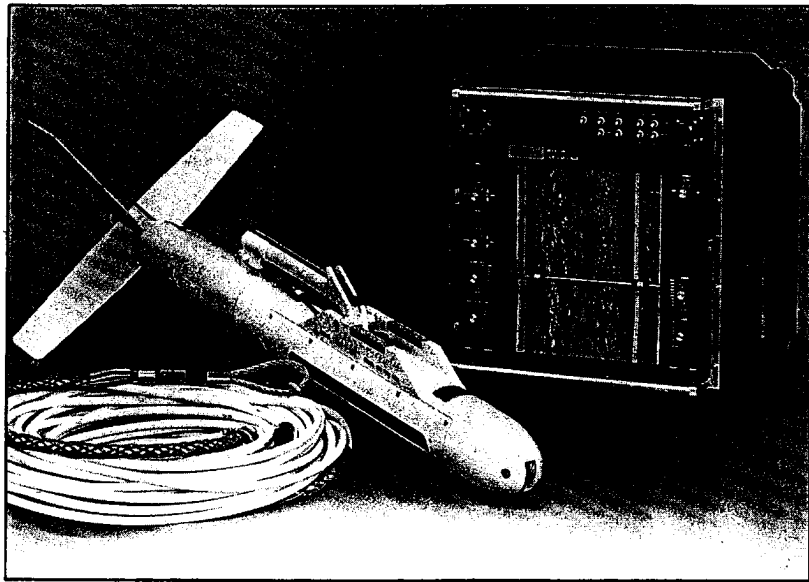


Figure 4. Illustration of the side scan sonar equipment

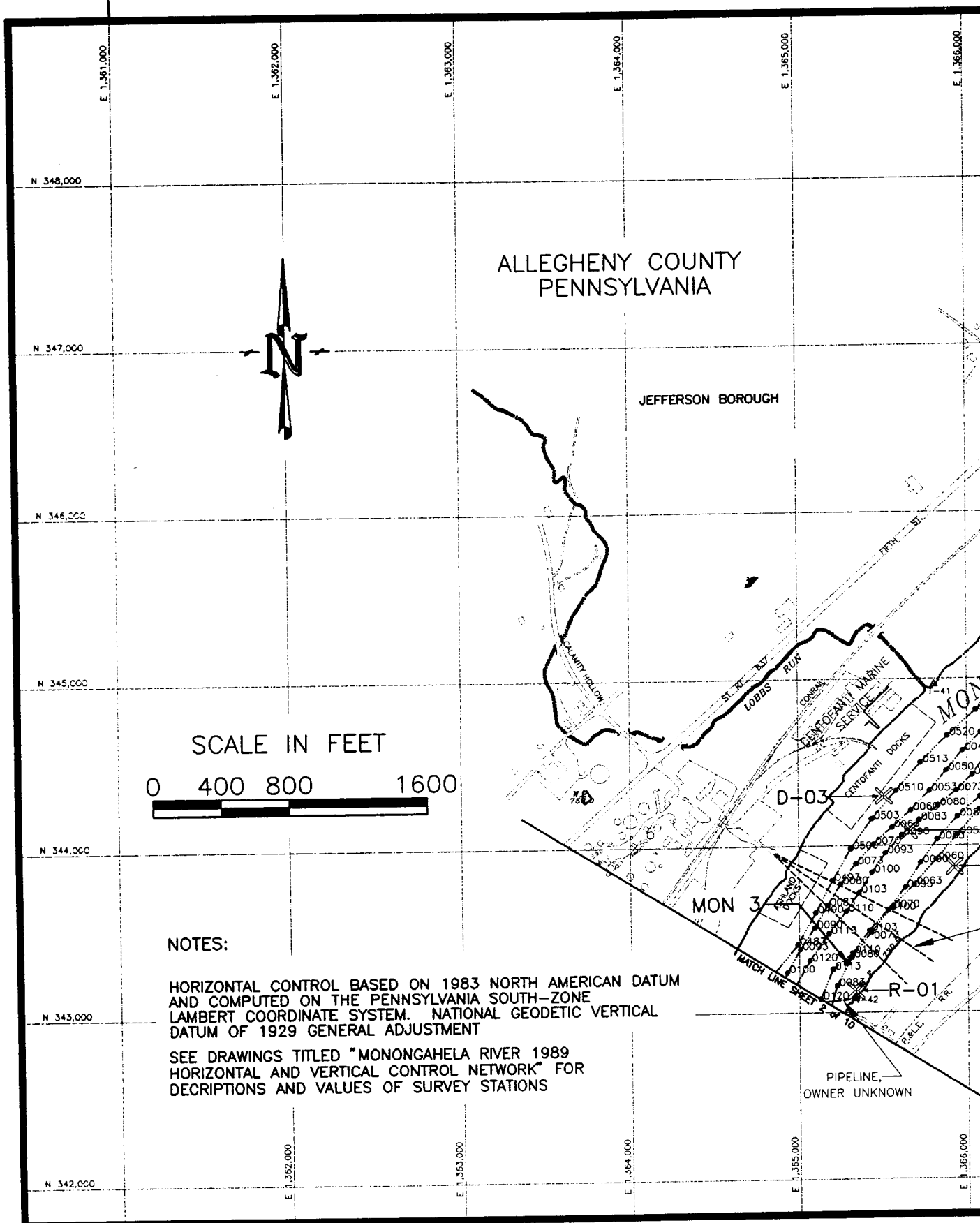
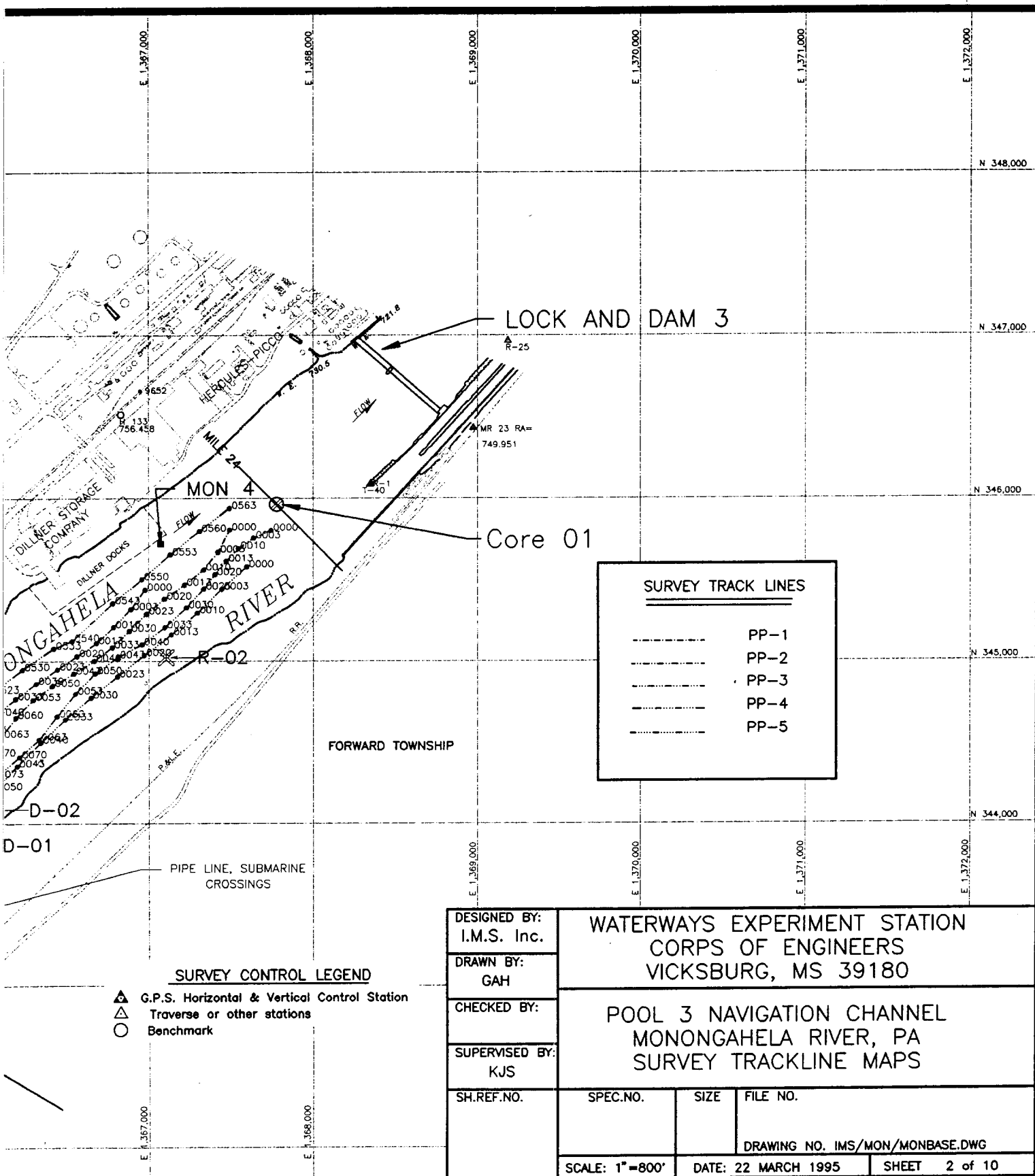


Figure 5. Seismic reflection survey lines, Pool 3, Monongahela River, PA



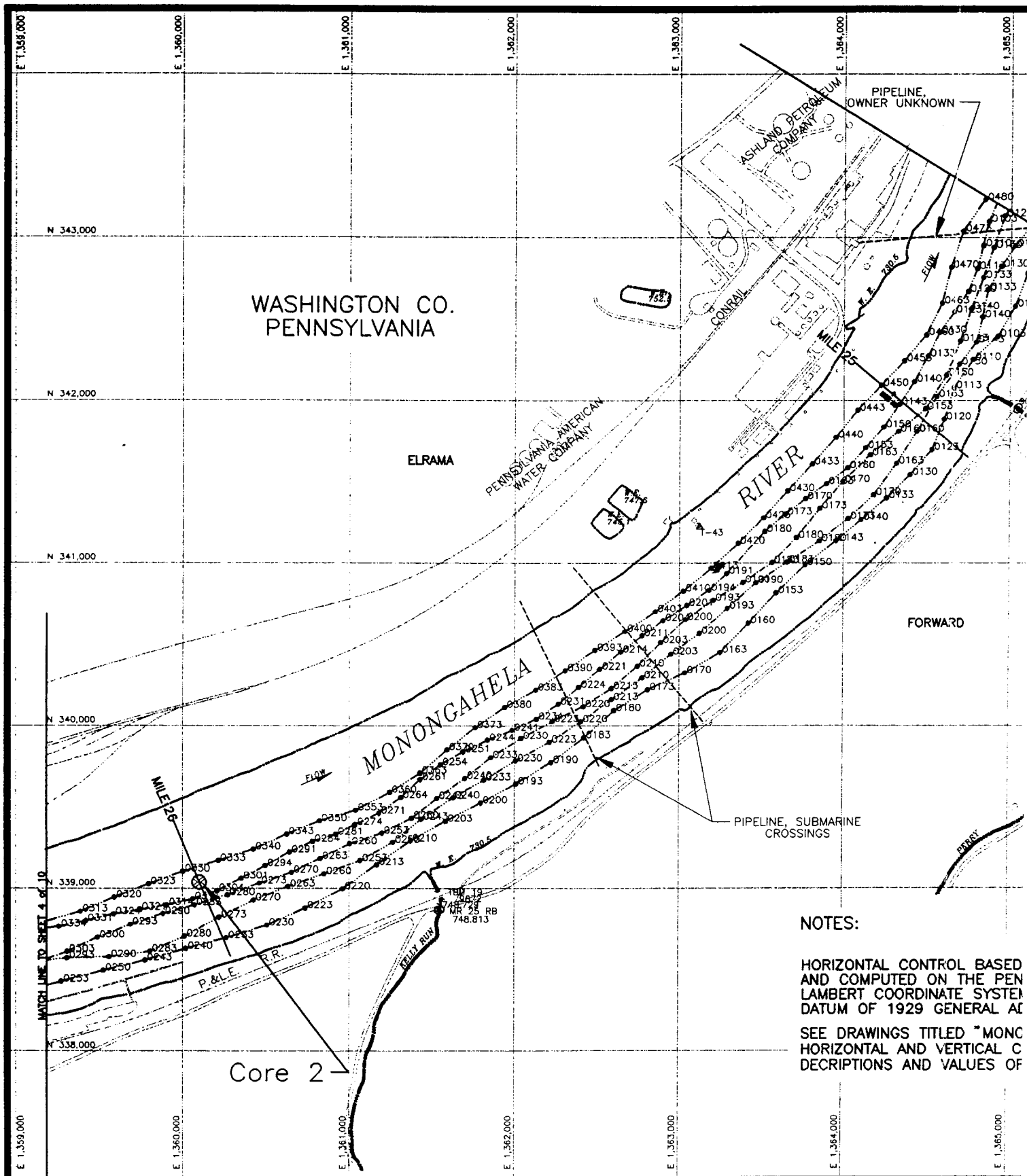
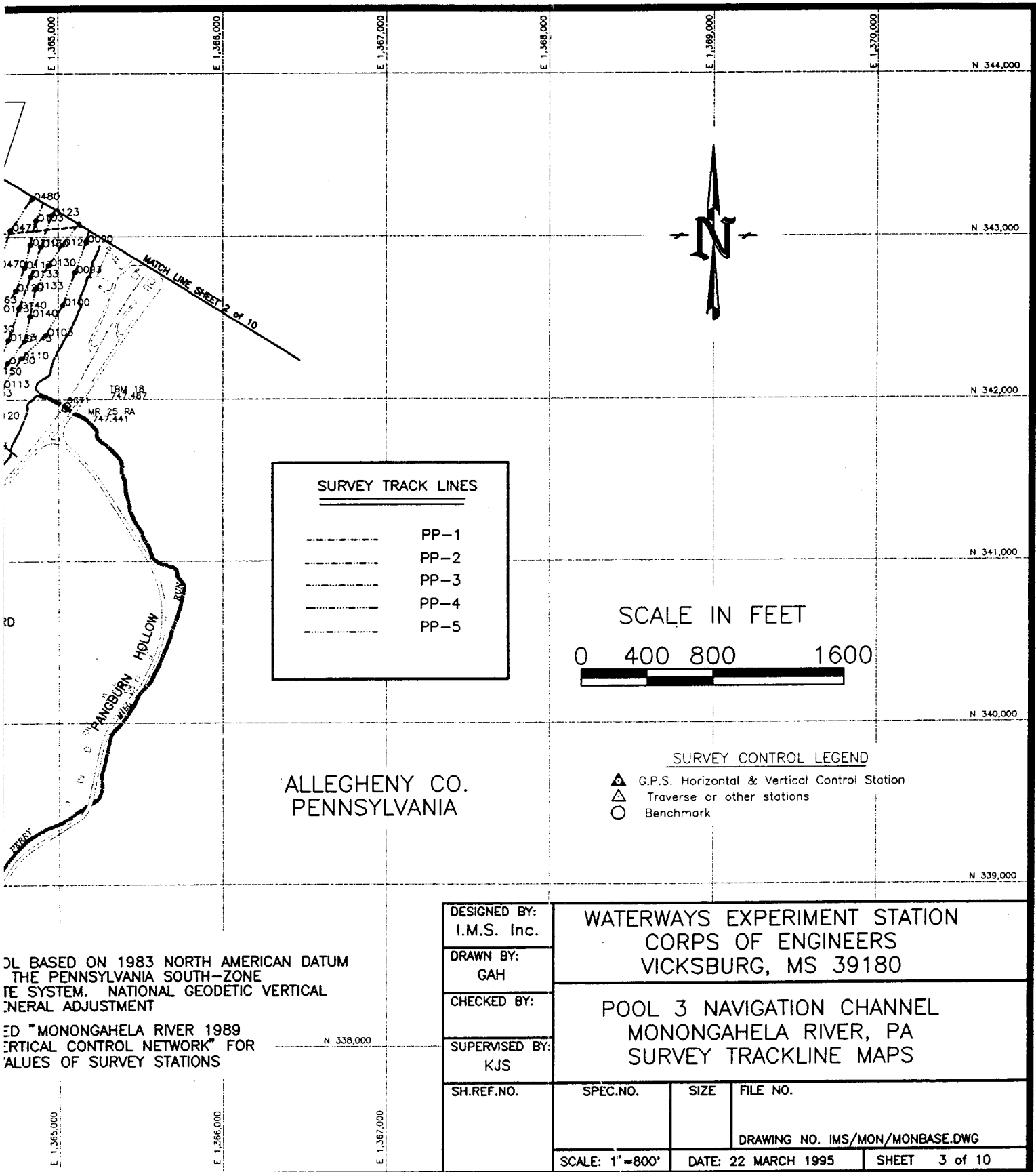


Figure 6. Seismic reflection survey lines, Pool 3, Monongahela River, PA

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SHEET 4 of 10

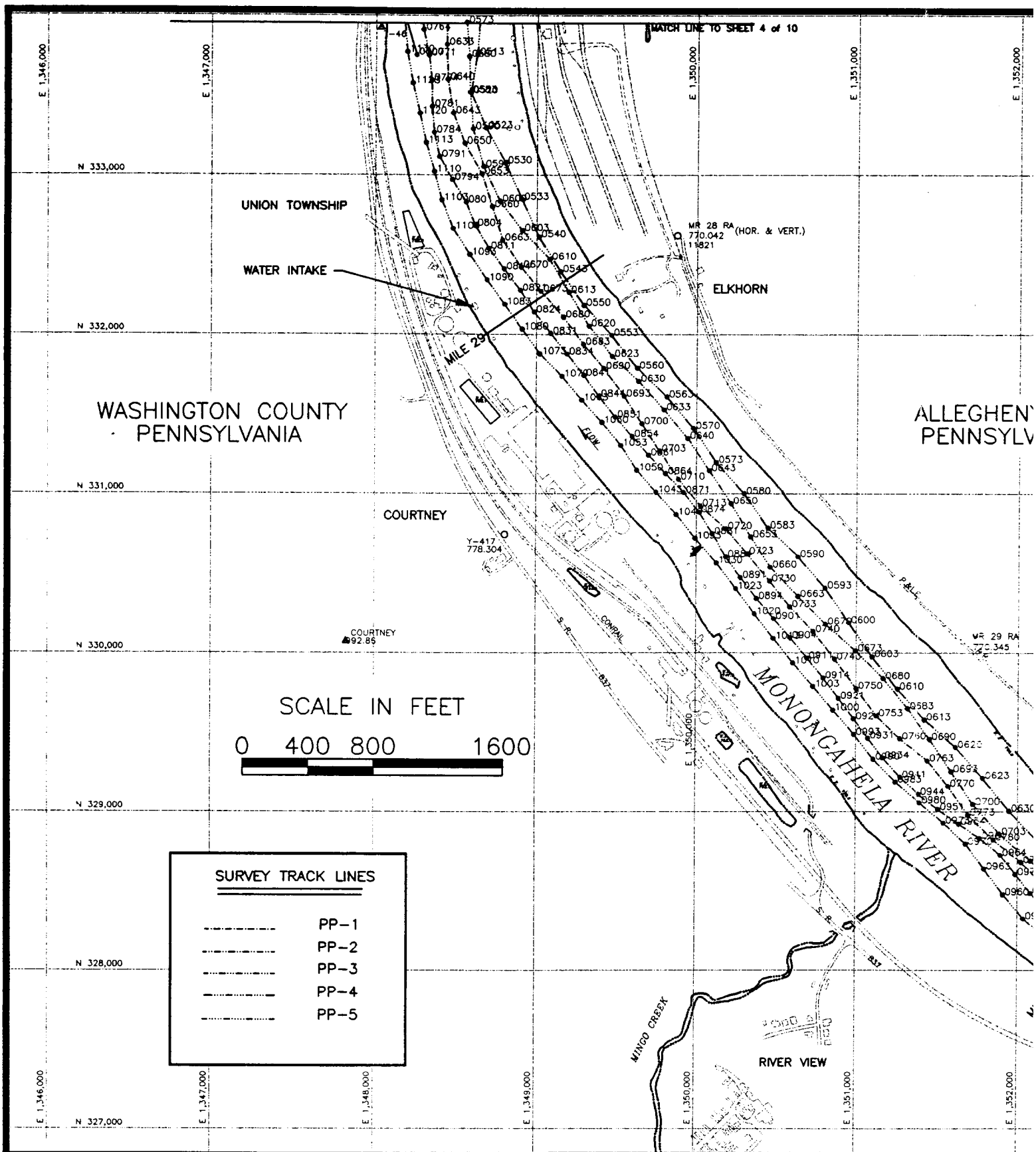
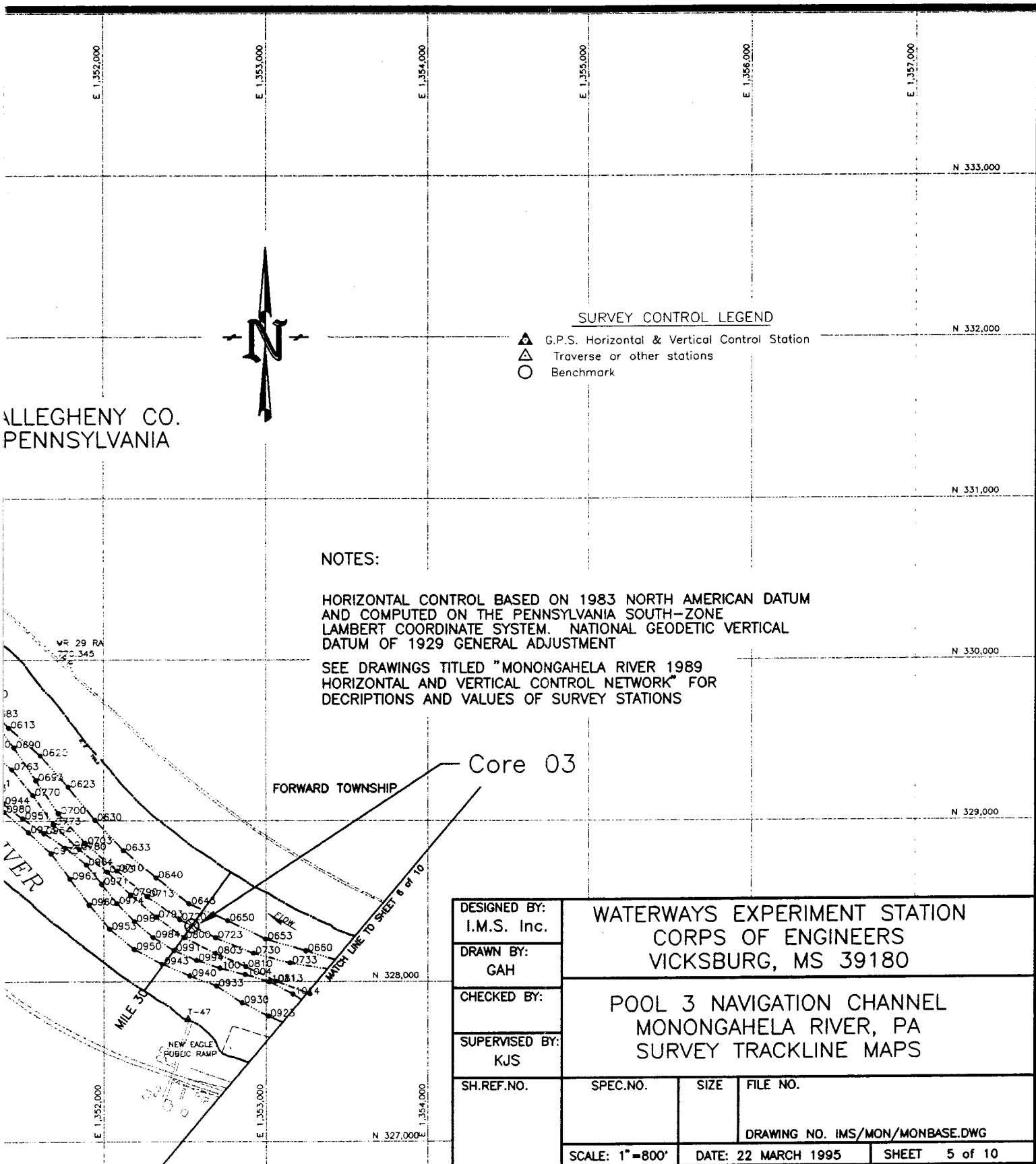
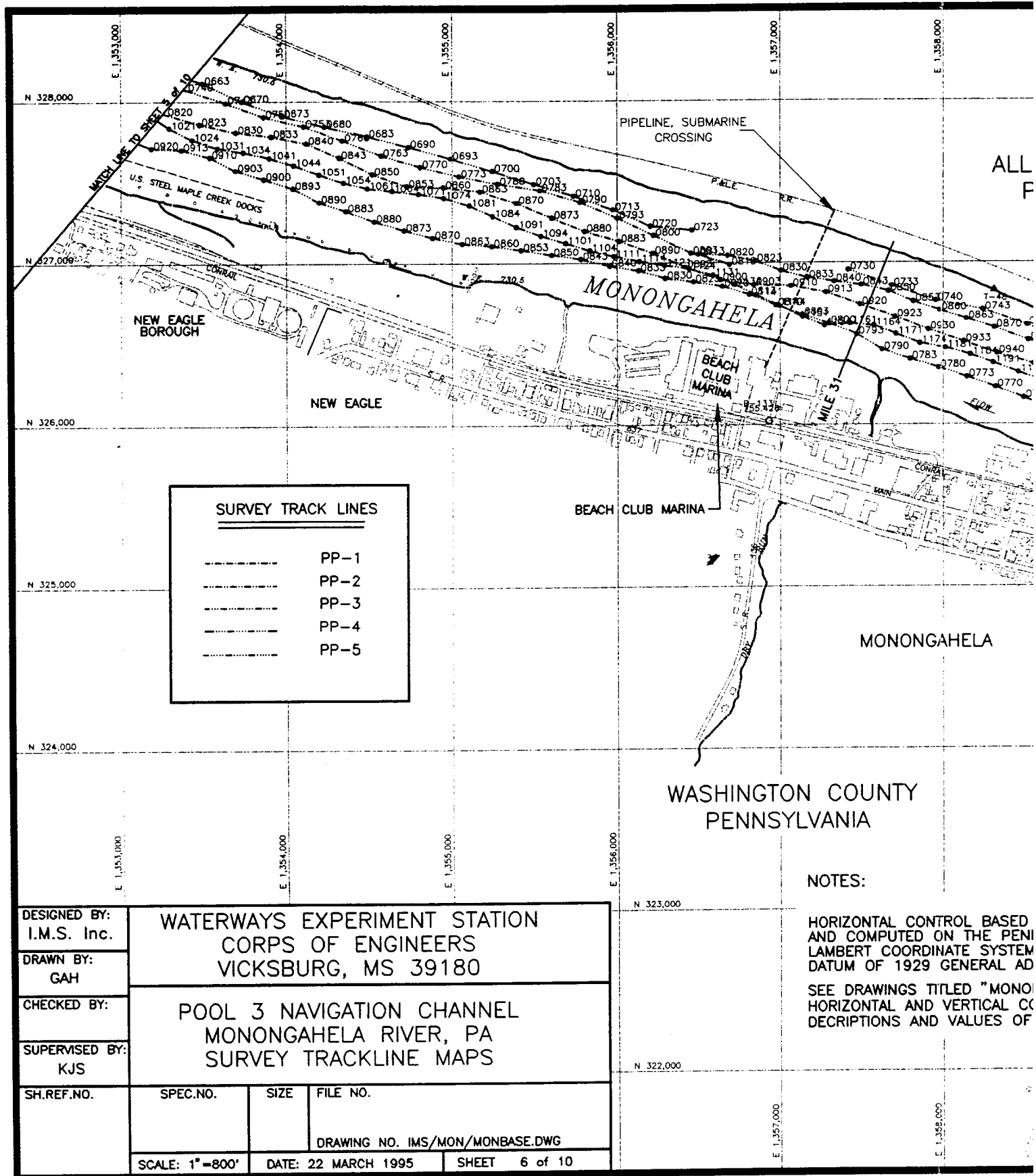


Figure 8. Seismic reflection survey lines, Pool 3, Monongahela River, PA

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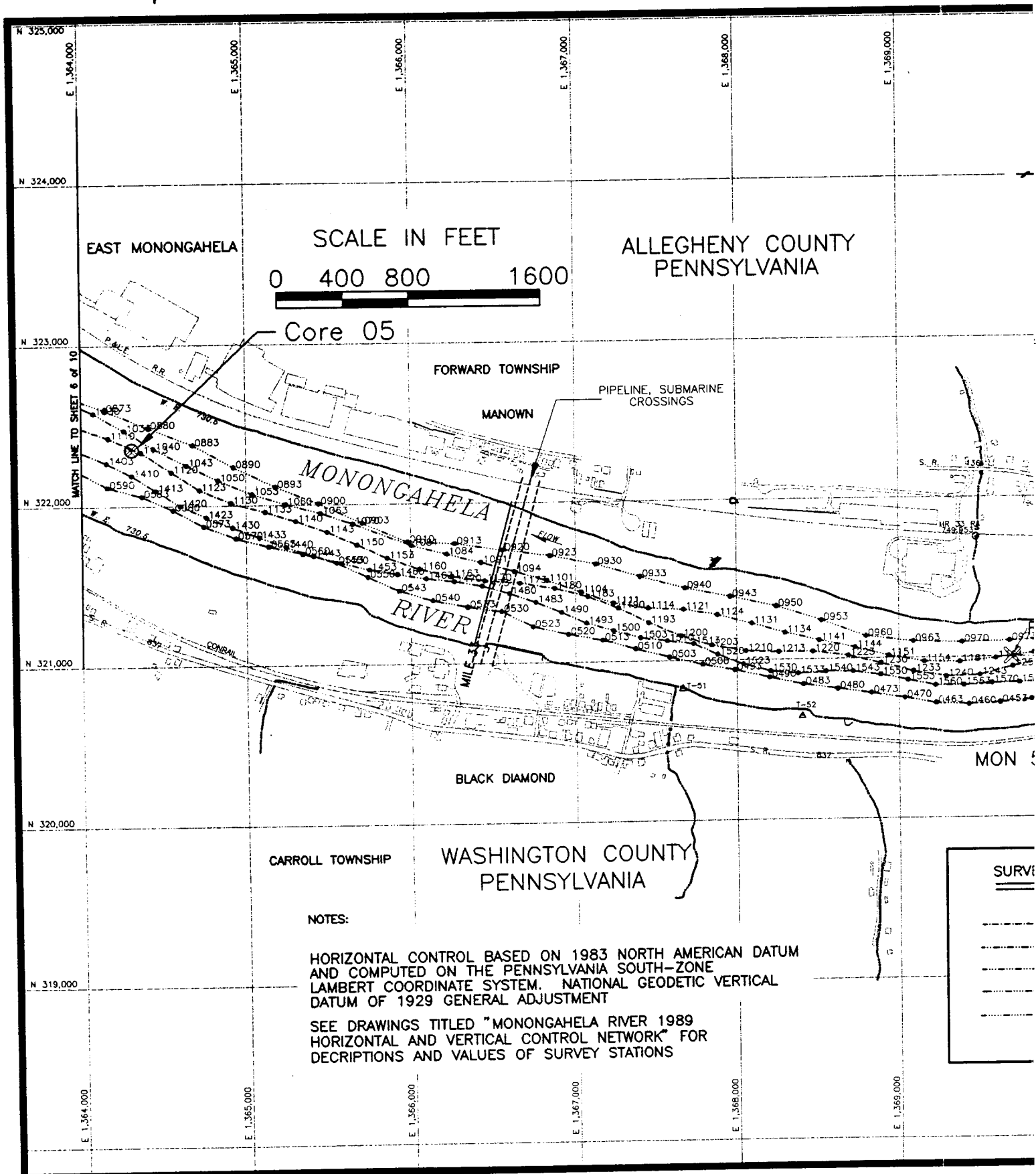
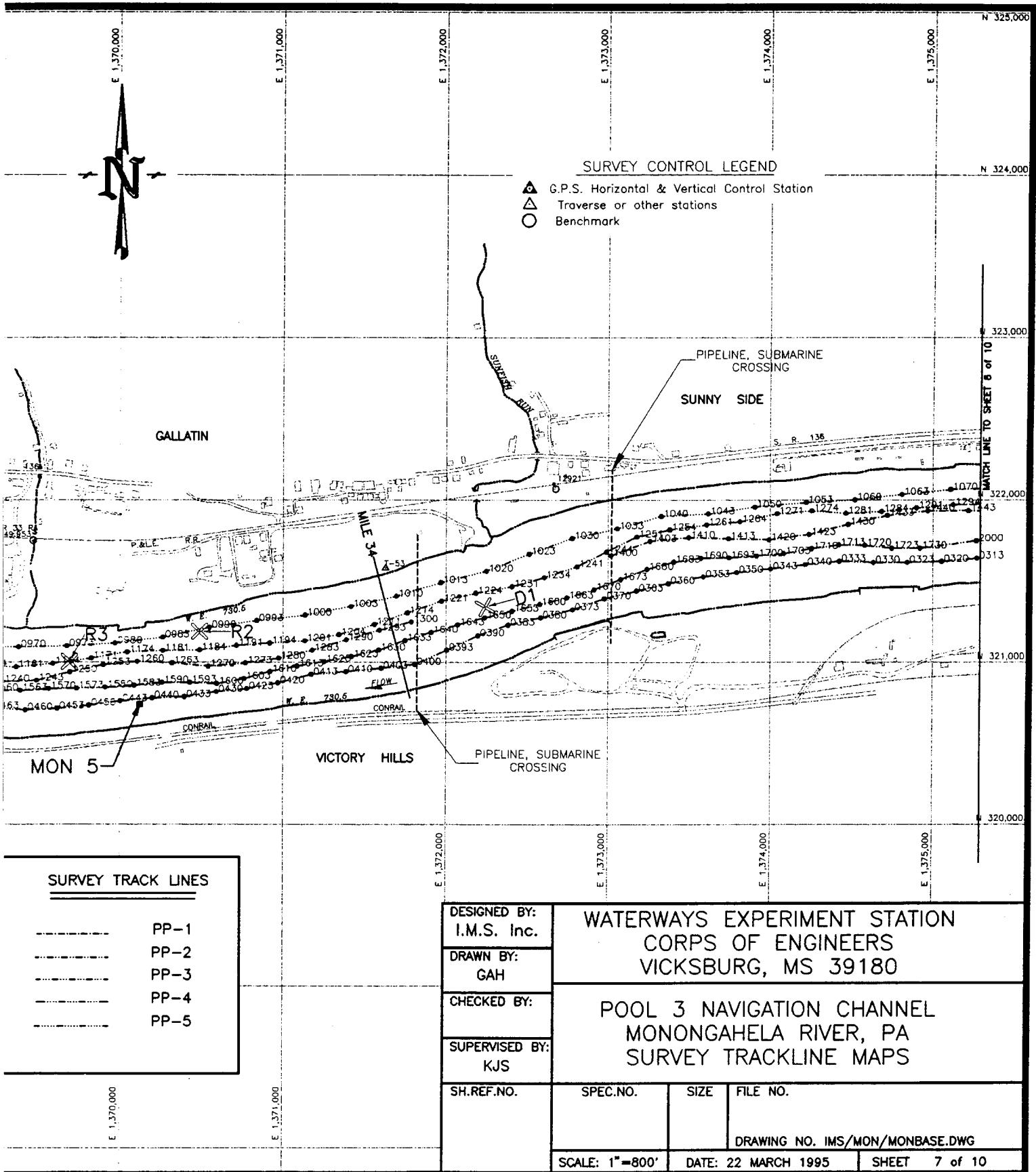


Figure 10. Seismic reflection survey lines, Pool 3, Monongahela River, PA

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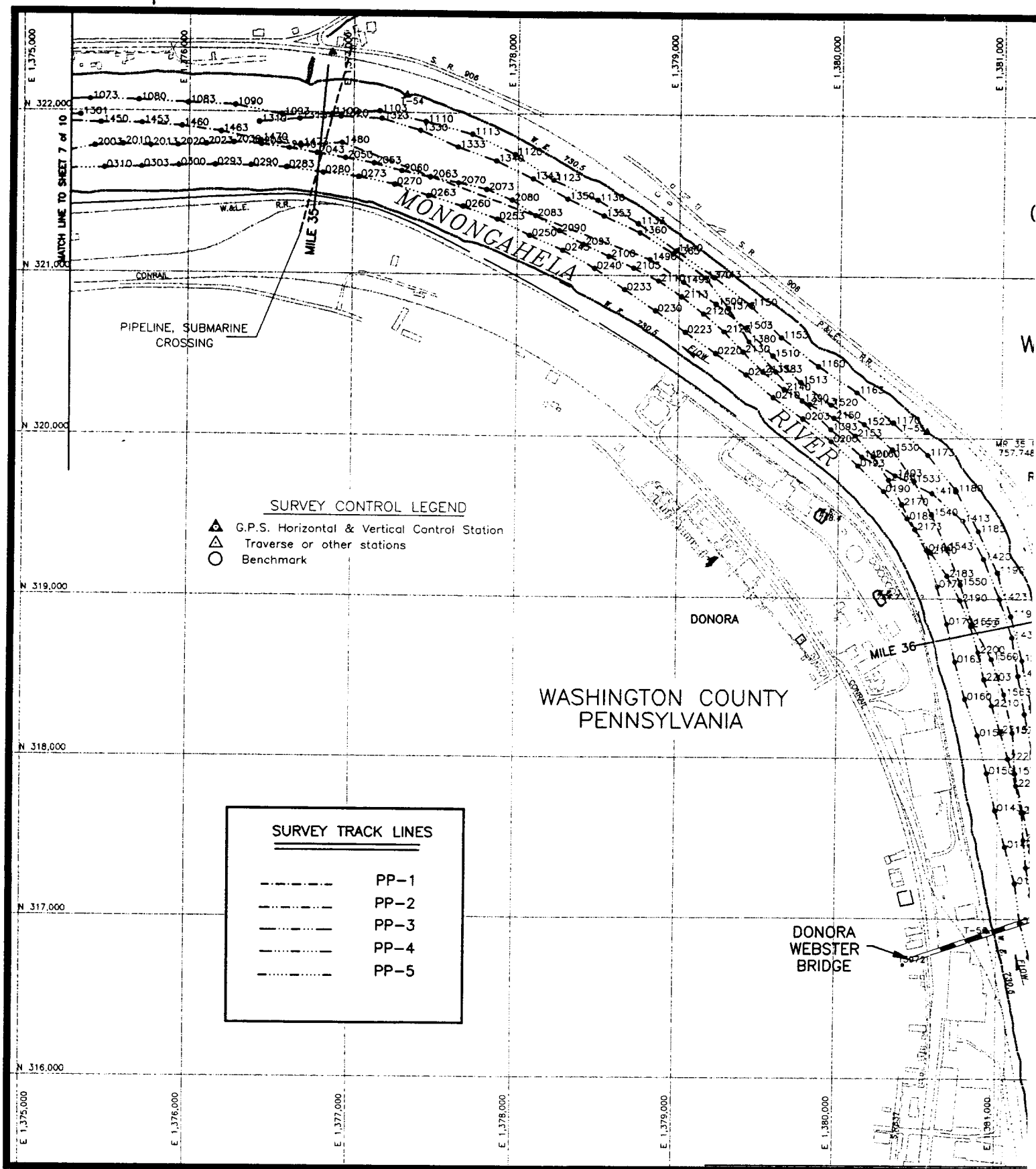
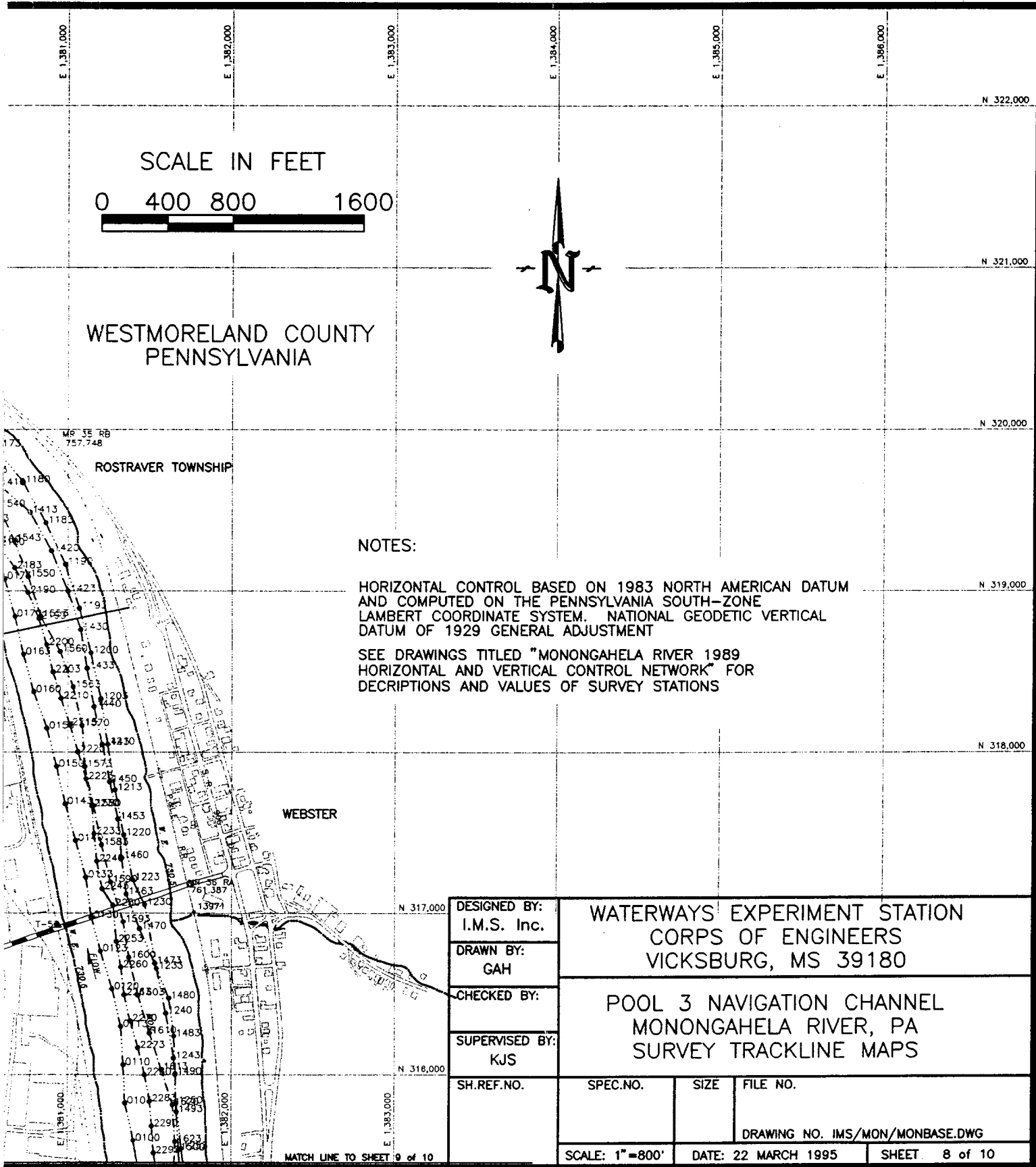


Figure 11. Seismic reflection survey lines, Pool 3, Monongahela River, PA

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NOTES:

HORIZONTAL CONTROL BASED ON 1983 NORTH AMERICAN DATUM
AND COMPUTED ON THE PENNSYLVANIA SOUTH-ZONE
LAMBERT COORDINATE SYSTEM. NATIONAL GEODETIC VERTICAL
DATUM OF 1929 GENERAL ADJUSTMENT

SEE DRAWINGS TITLED "MONONGAHELA RIVER 1989
HORIZONTAL AND VERTICAL CONTROL NETWORK" FOR
DESCRIPTORS AND VALUES OF SURVEY STATIONS

DESIGNED BY:
I.M.S. Inc.

DRAWN BY:
GAH

CHECKED BY:

SUPERVISED BY:
KJS

SH.REF.NO.

WATERWAYS EXPERIMENT STATION
CORPS OF ENGINEERS
VICKSBURG, MS 39180

POOL 3 NAVIGATION CHANNEL
MONONGAHELA RIVER, PA
SURVEY TRACKLINE MAPS

SPEC.NO.

SIZE

FILE NO.

DRAWING NO. IMS/MON/MONBASE.DWG

SCALE: 1"=800'

DATE: 22 MARCH 1995

SHEET 8 of 10

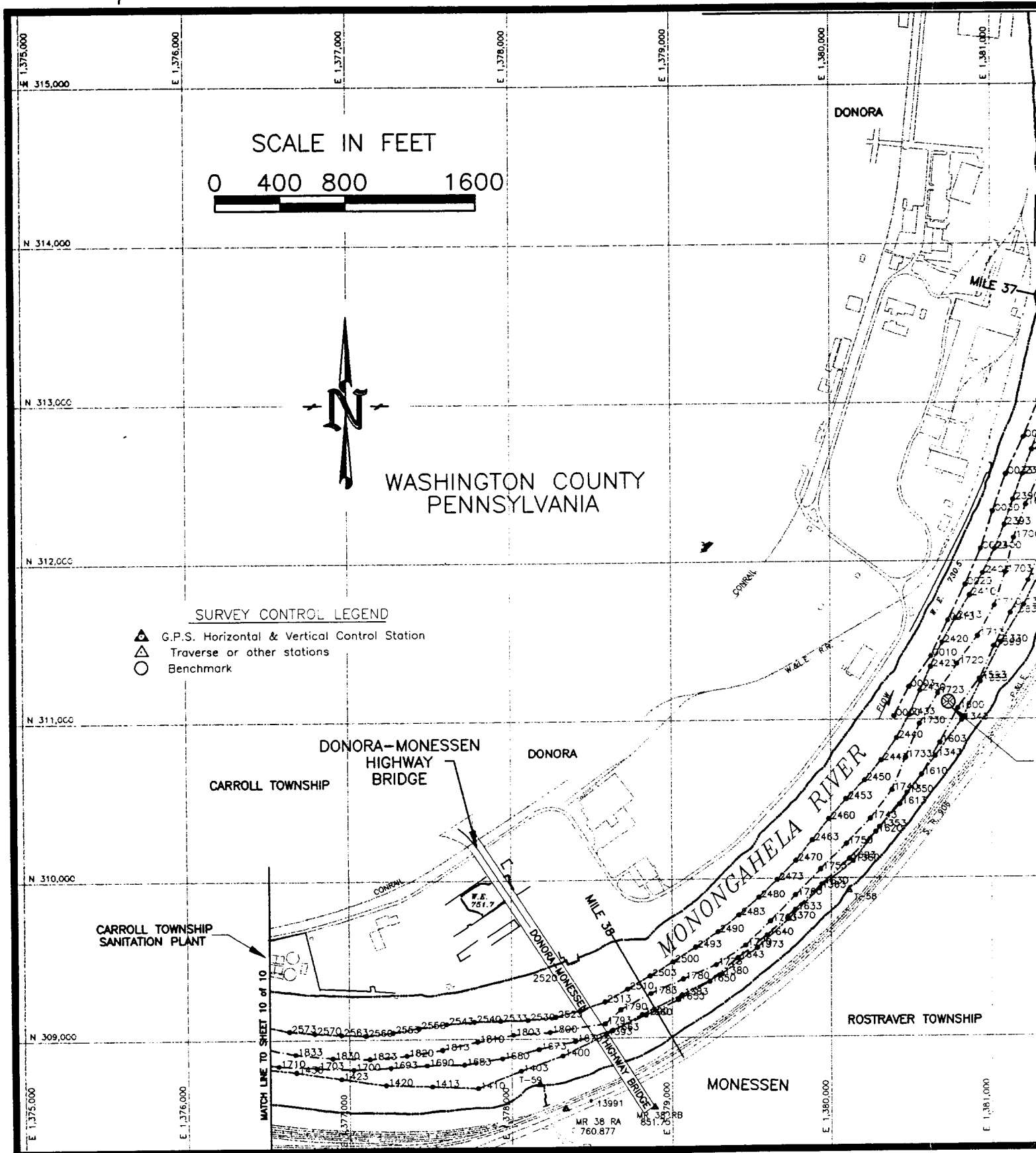
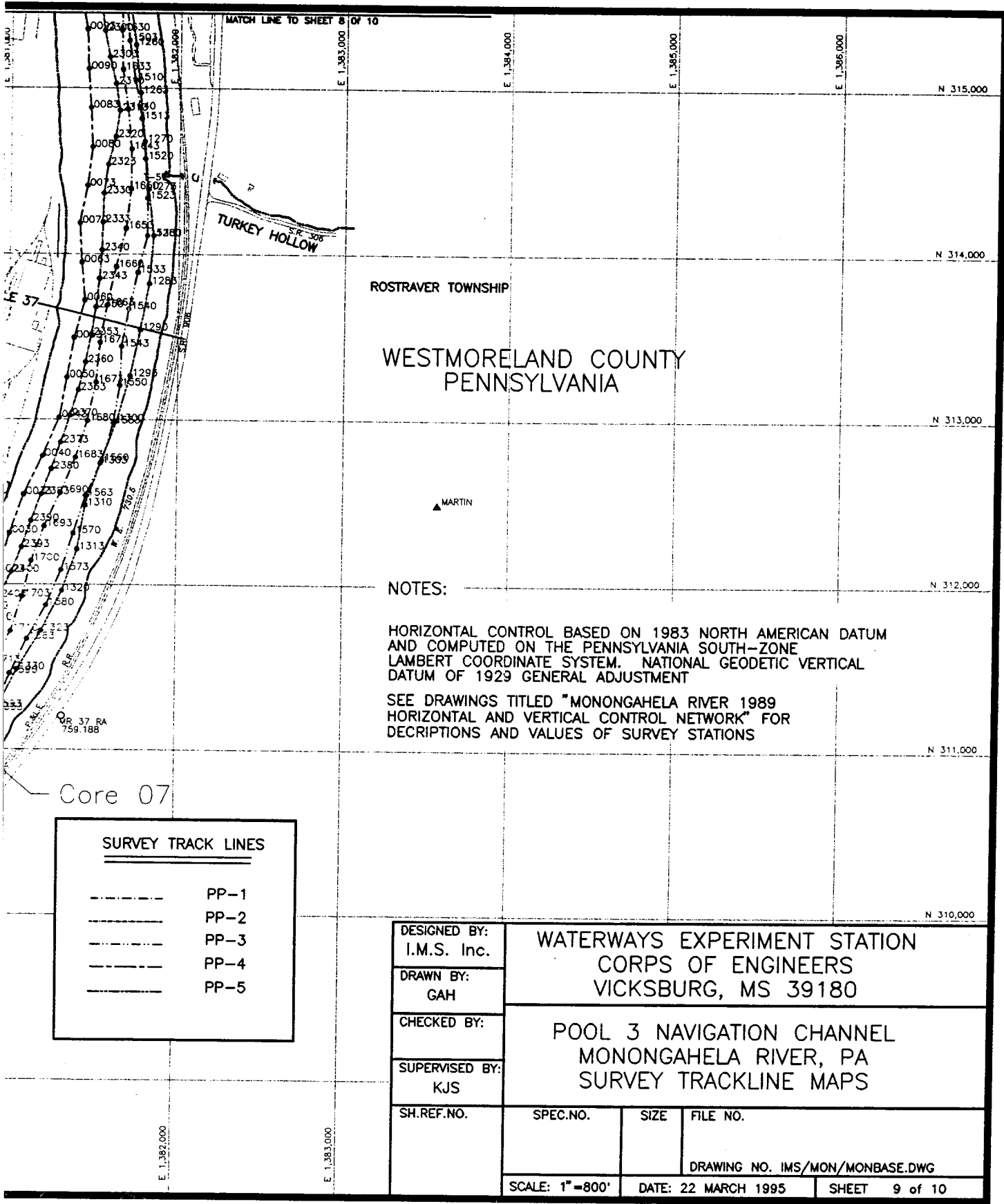
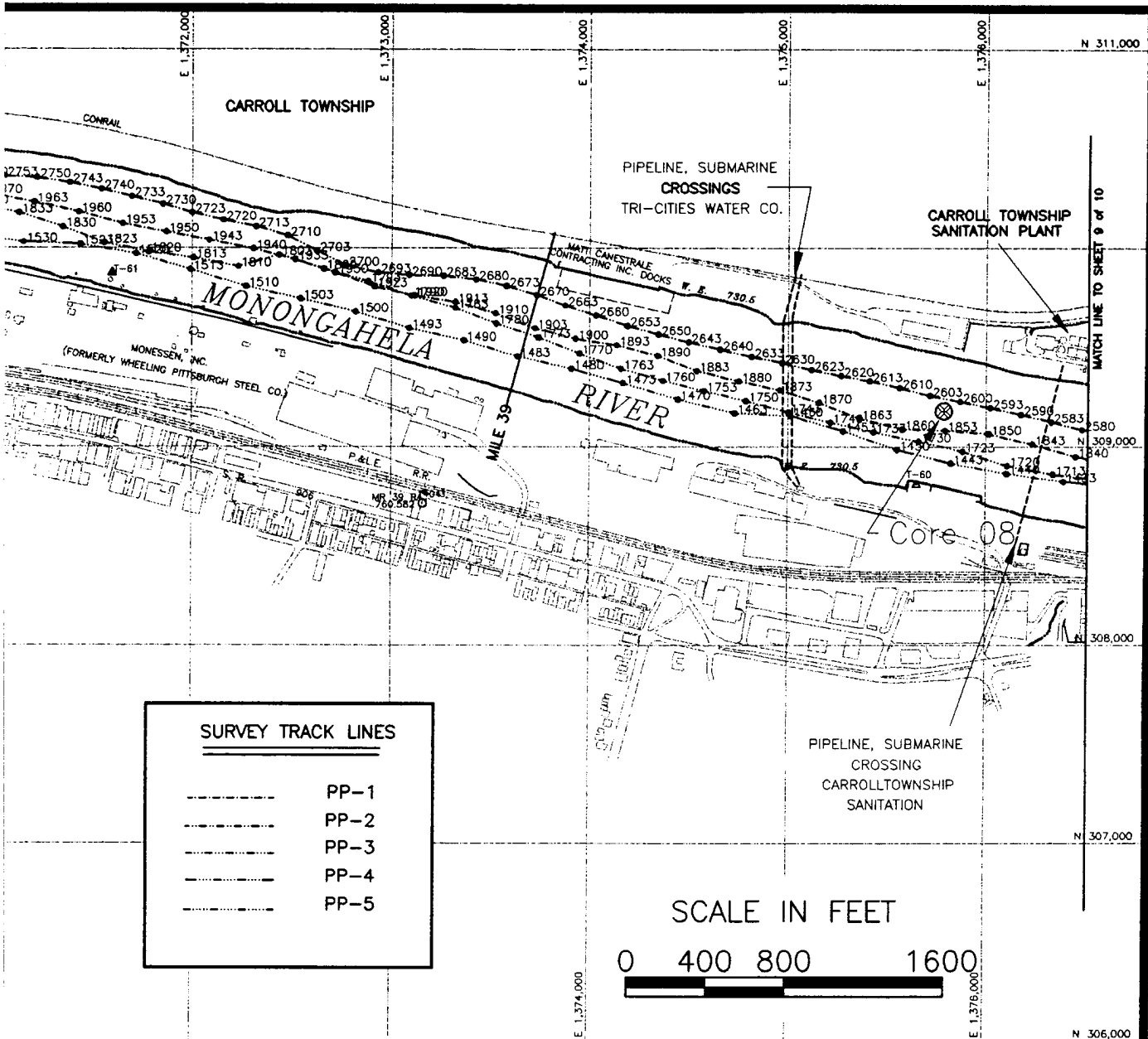


Figure 12. Seismic reflection survey lines, Pool 3, Monongahela River, PA

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DESIGNED BY: I.M.S. Inc.	WATERWAYS EXPERIMENT STATION CORPS OF ENGINEERS VICKSBURG, MS 39180		
DRAWN BY: GAH			
CHECKED BY:	POOL 3 NAVIGATION CHANNEL MONONGAHELA RIVER, PA SURVEY TRACKLINE MAPS		
SUPERVISED BY: KJS			
SH.REF.NO.	SPEC.NO.	SIZE	FILE NO.
			DRAWING NO. IMS/MON/MONBASE.DWG
SCALE: 1"=800'		DATE: 22 MARCH 1995	SHEET 10 of 10



Figure 14. Geophysical interpretation showing Areas MR-1 through MR-5, Pool 3, Monongahela River

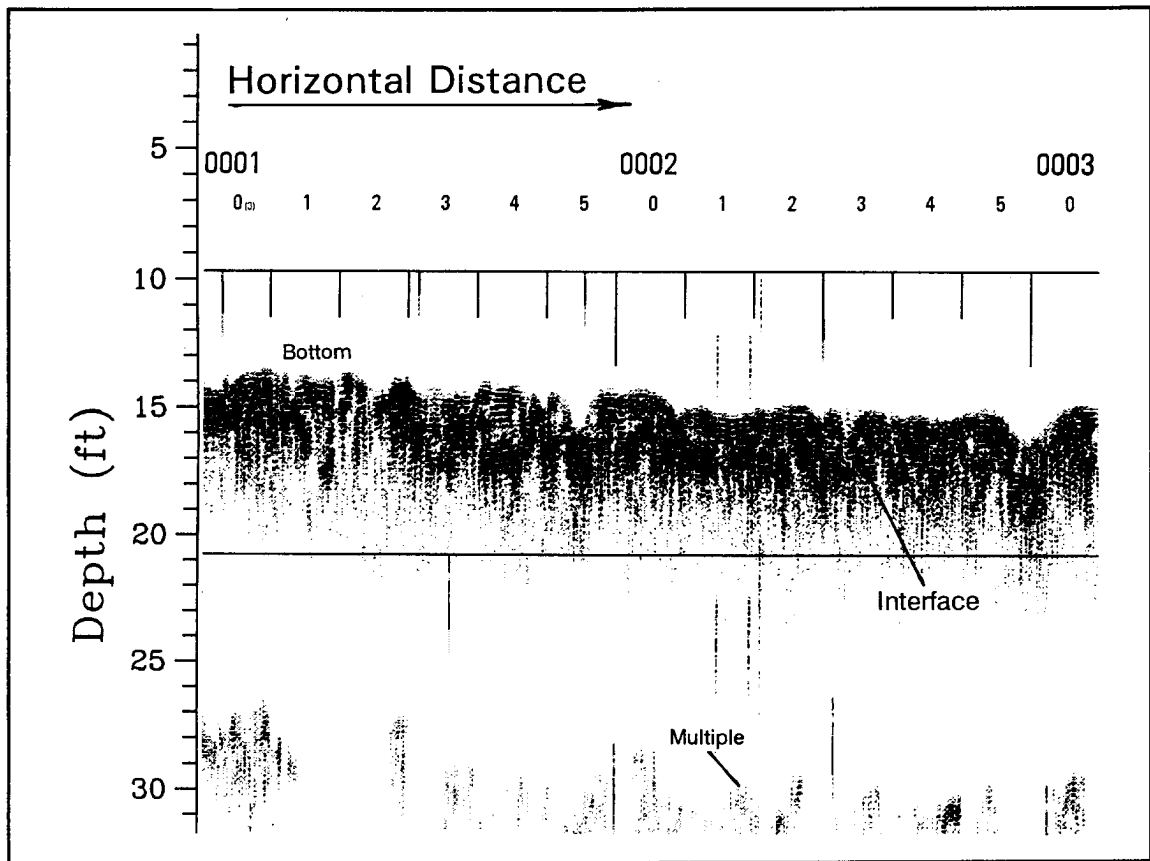
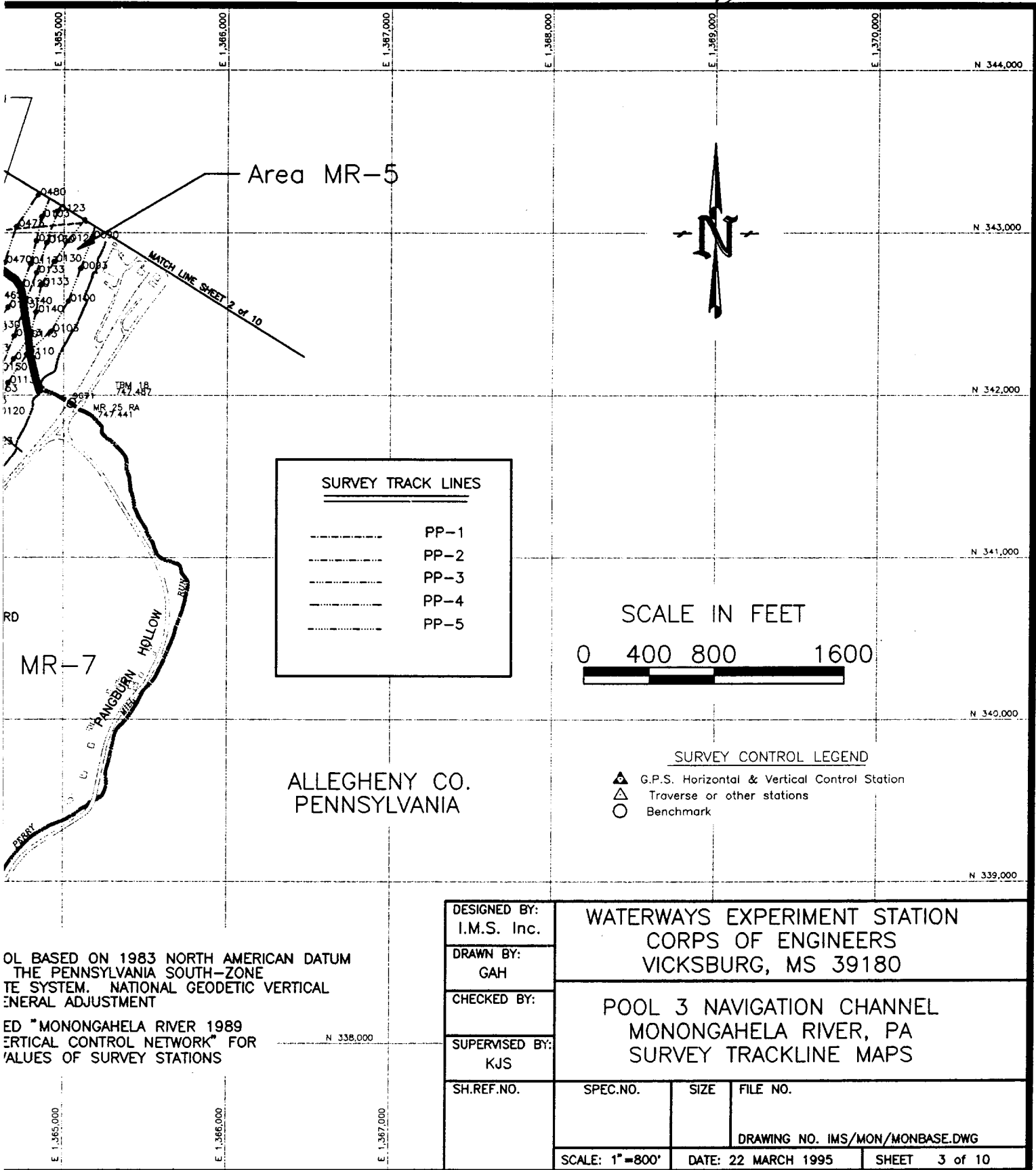


Figure 15. Subbottom seismic reflection record along survey line PP1 (files 0010-0030) near River Mile (RM) 24.2, Monongahela River



Figure 16. Geophysical interpretation showing Areas MR-5 through MR-8, Pool 3, Monongahela River



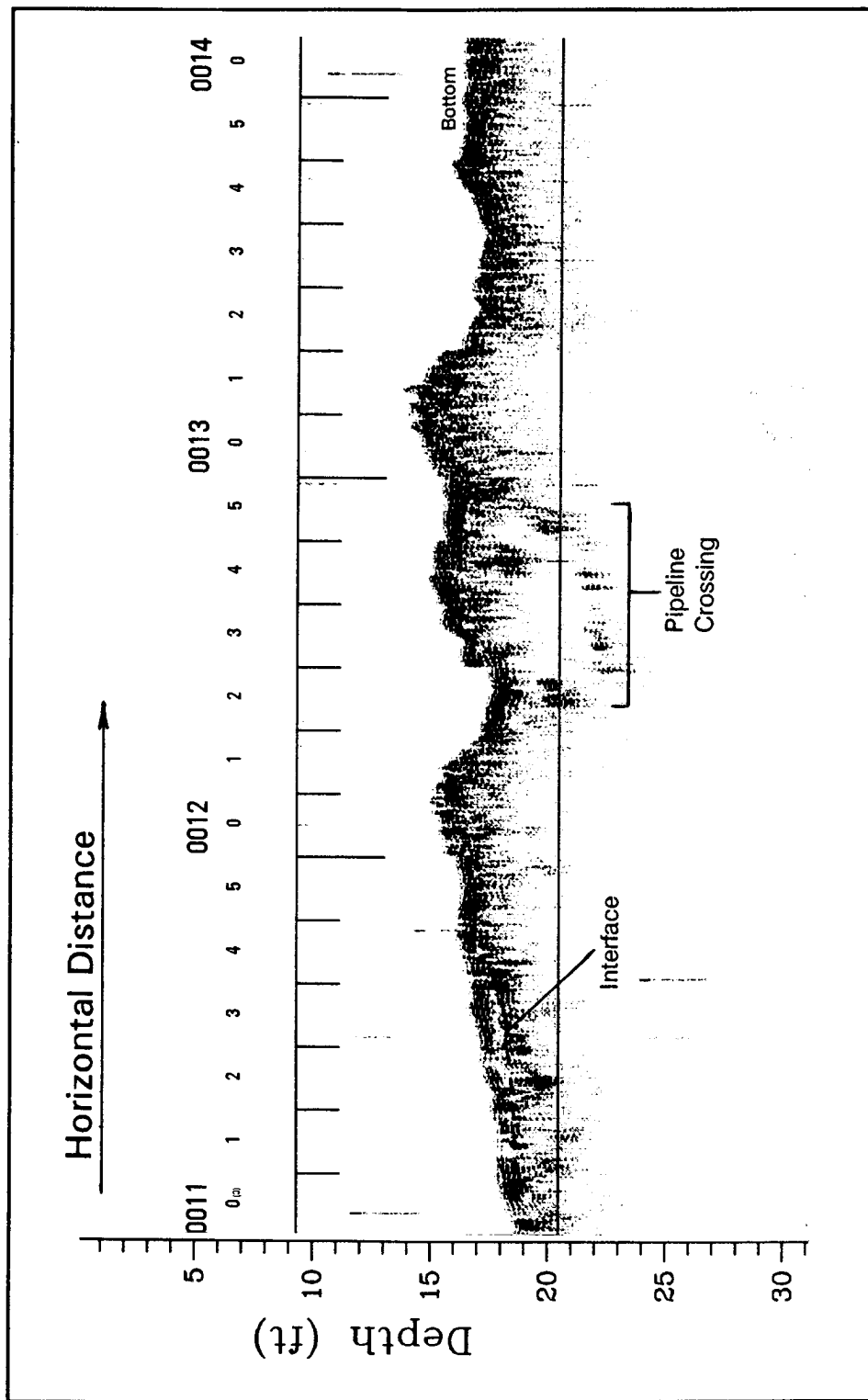


Figure 17. Subbottom seismic reflection record along survey line PP1 (files 0110-0130) near RM 24.8, Monongahela River

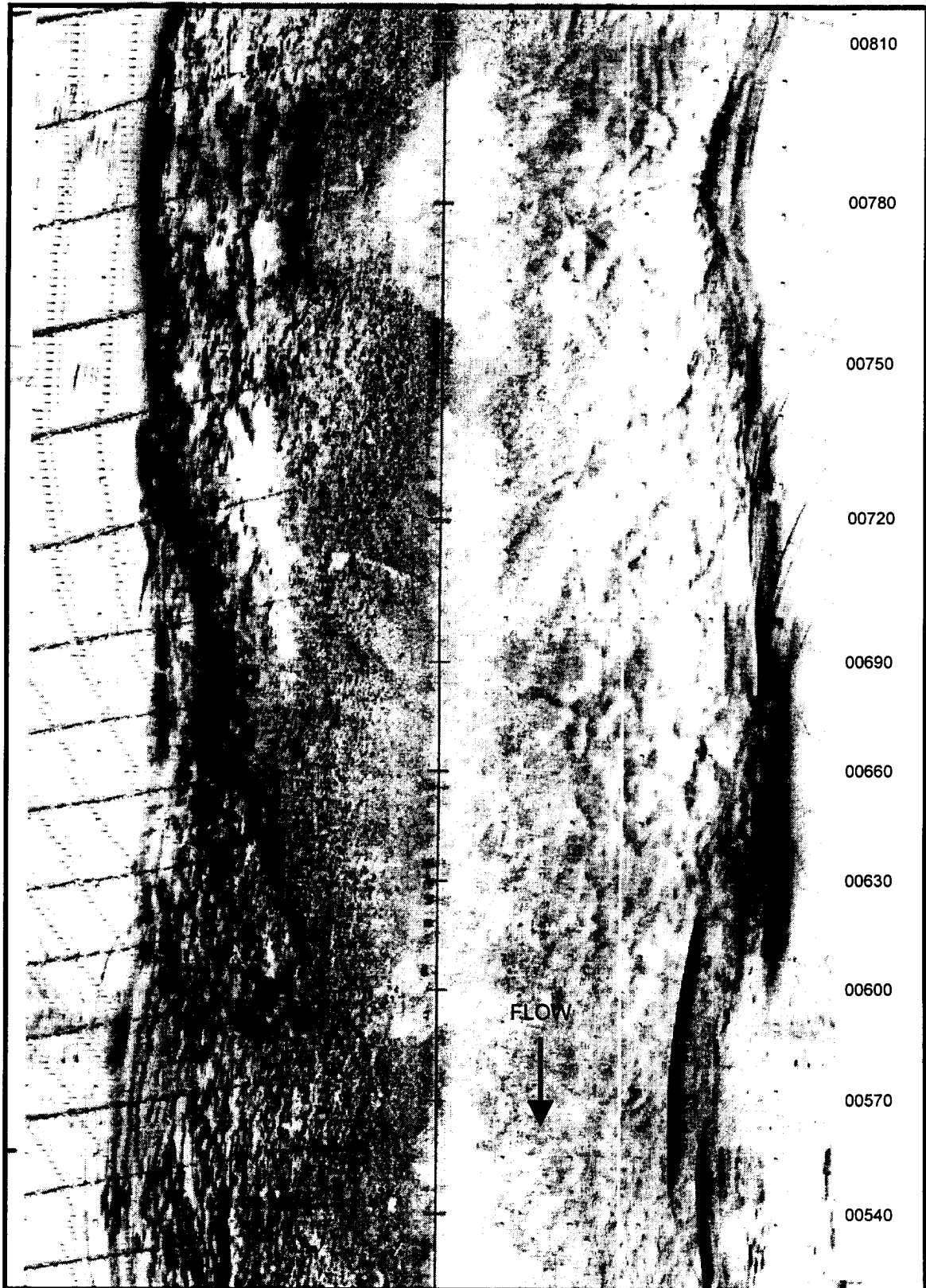
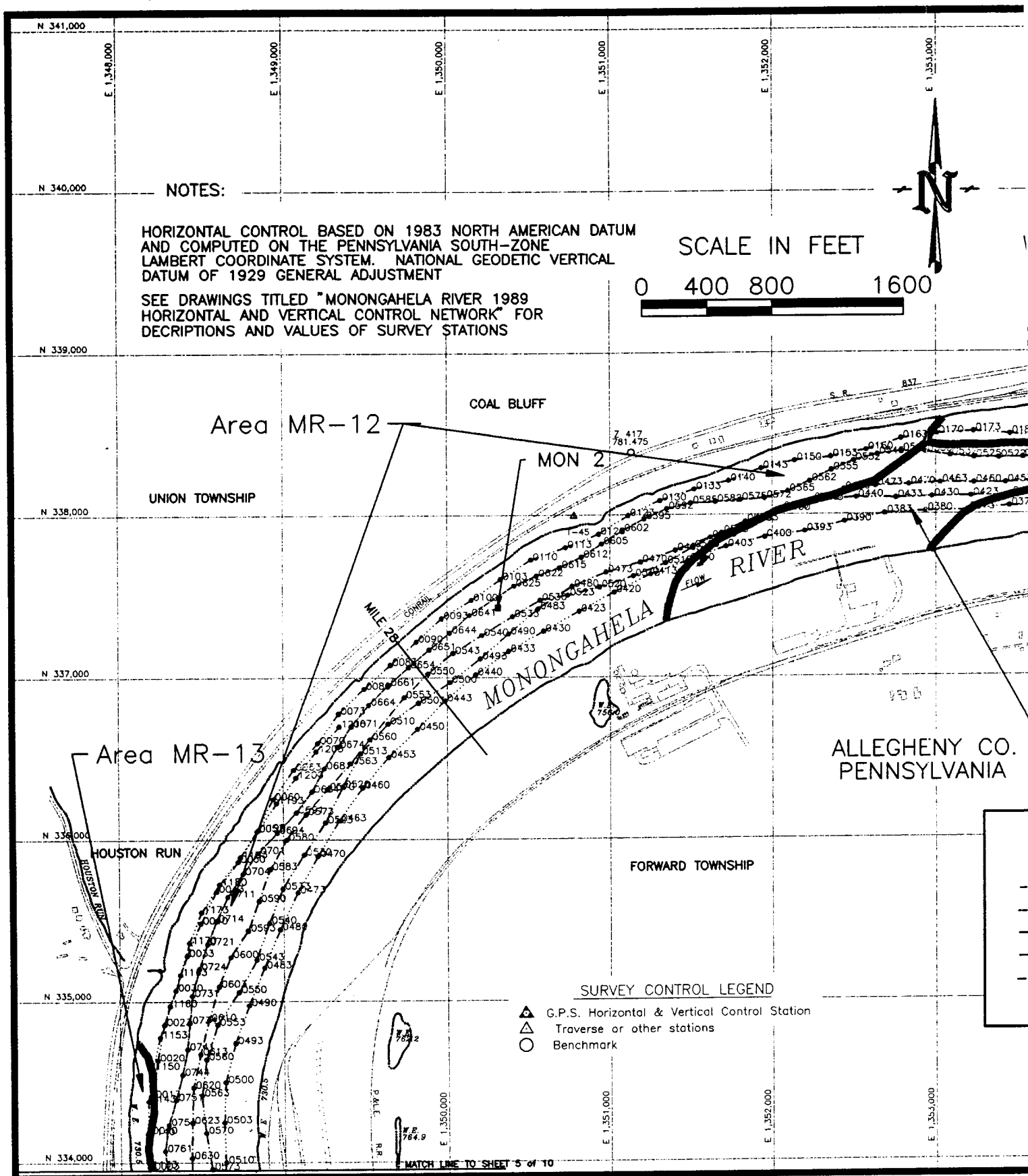


Figure 18. Side scan sonar record along survey line PP1 (fix points 0540-0810) near RM 24.8, Monongahela River



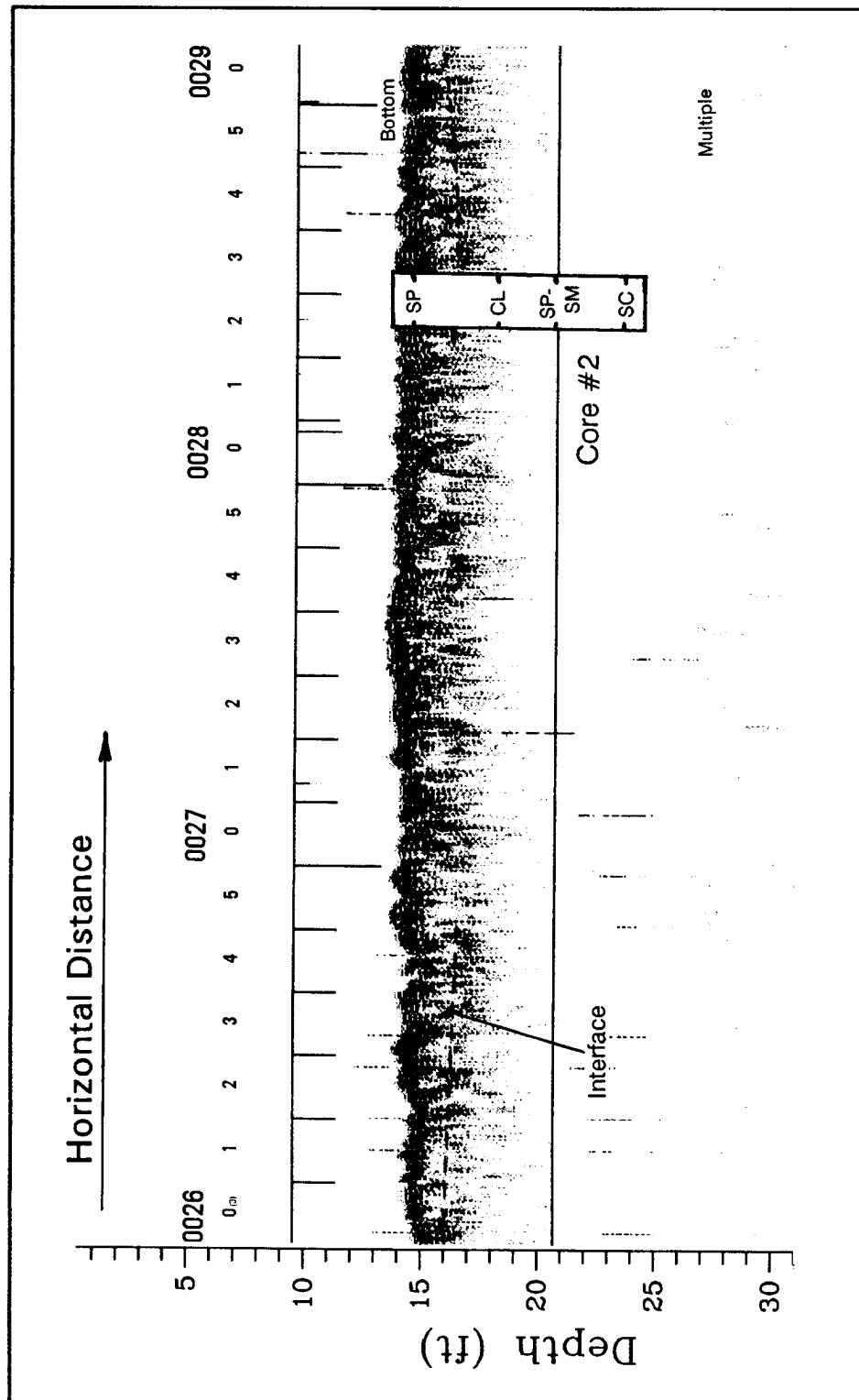


Figure 20. Subbottom seismic reflection record along survey line PP1 (files 0260-0290) near RM 25.9, Monongahela River

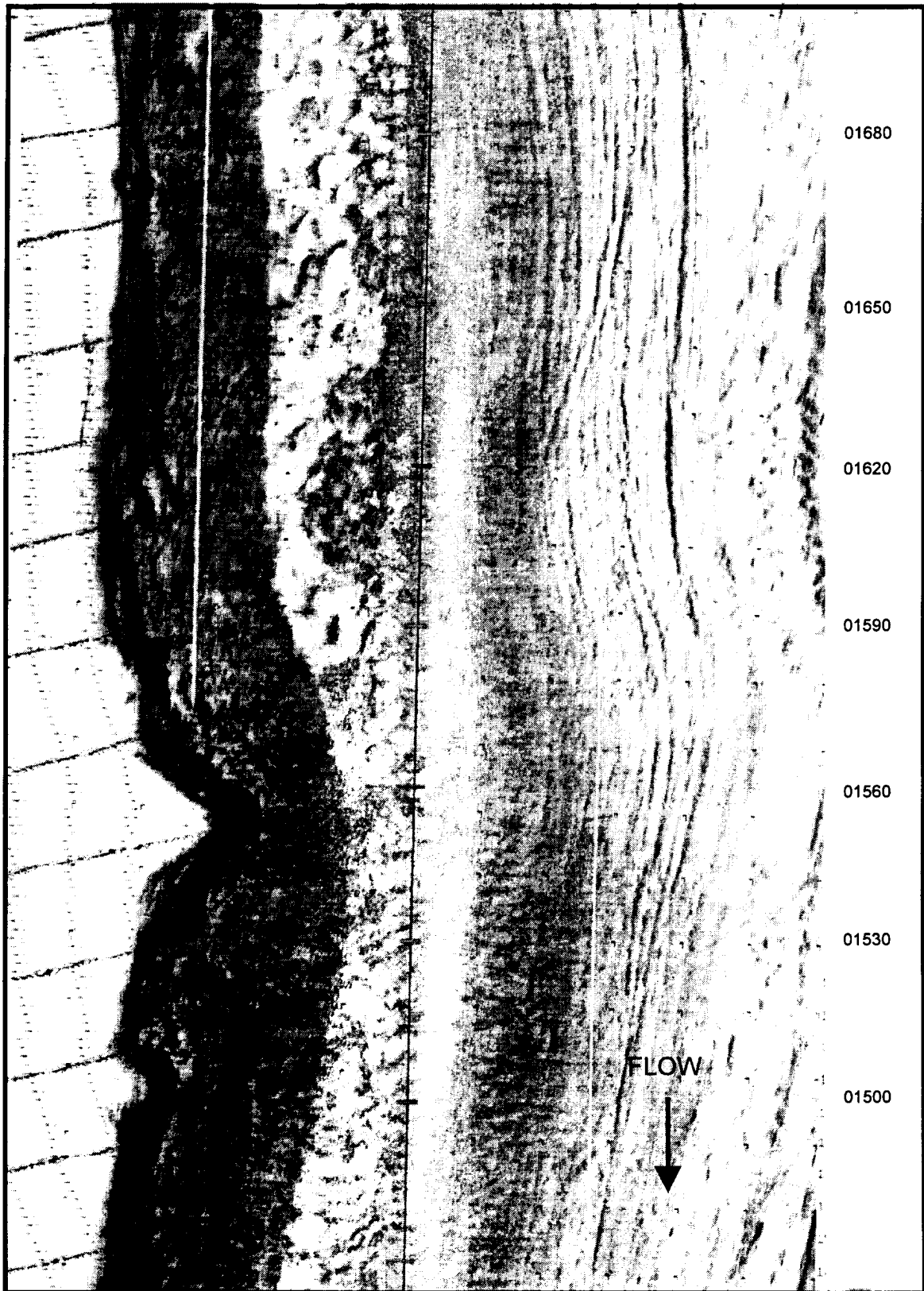


Figure 21. Side scan sonar record along survey line PP1 (fix points 1500-1680) near RM 25.9, Monongahela River

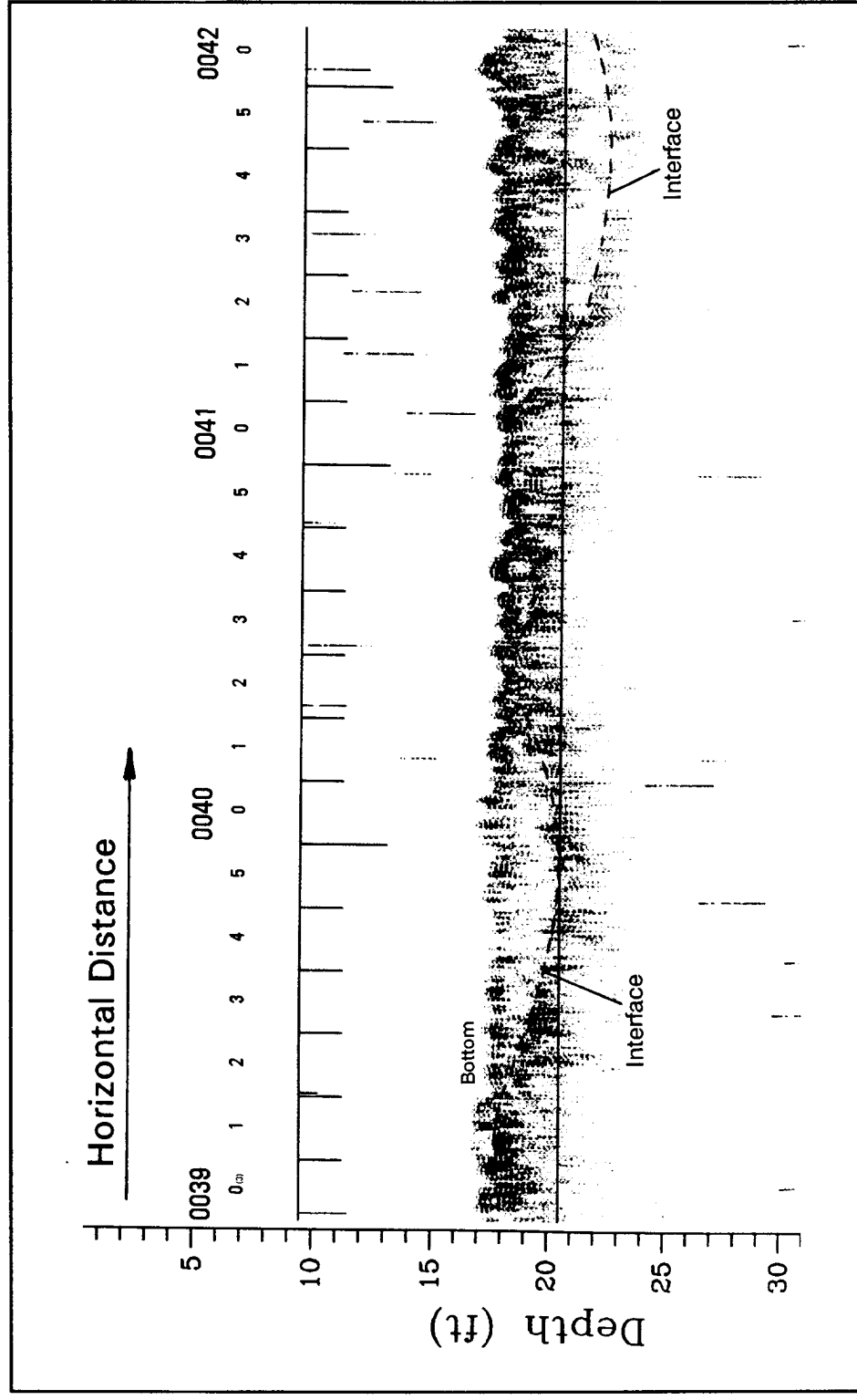


Figure 22. Subbottom seismic reflection record along survey line PP1 (files 0390-0420) near RM 26.9, Monongahela River

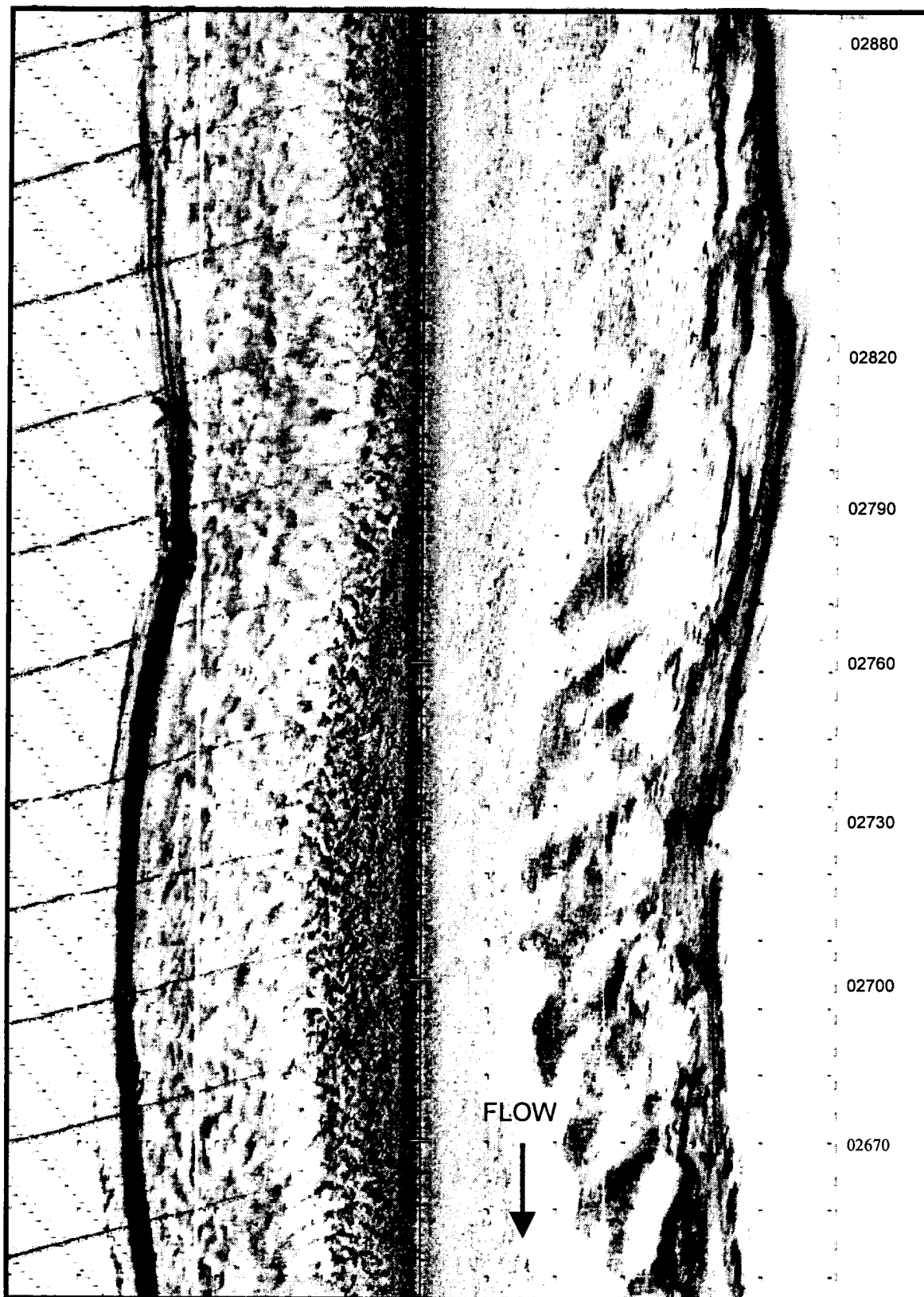


Figure 23. Side scan sonar record along survey line PP1 (fix points 2670-2880) near RM 27.2, Monongahela River

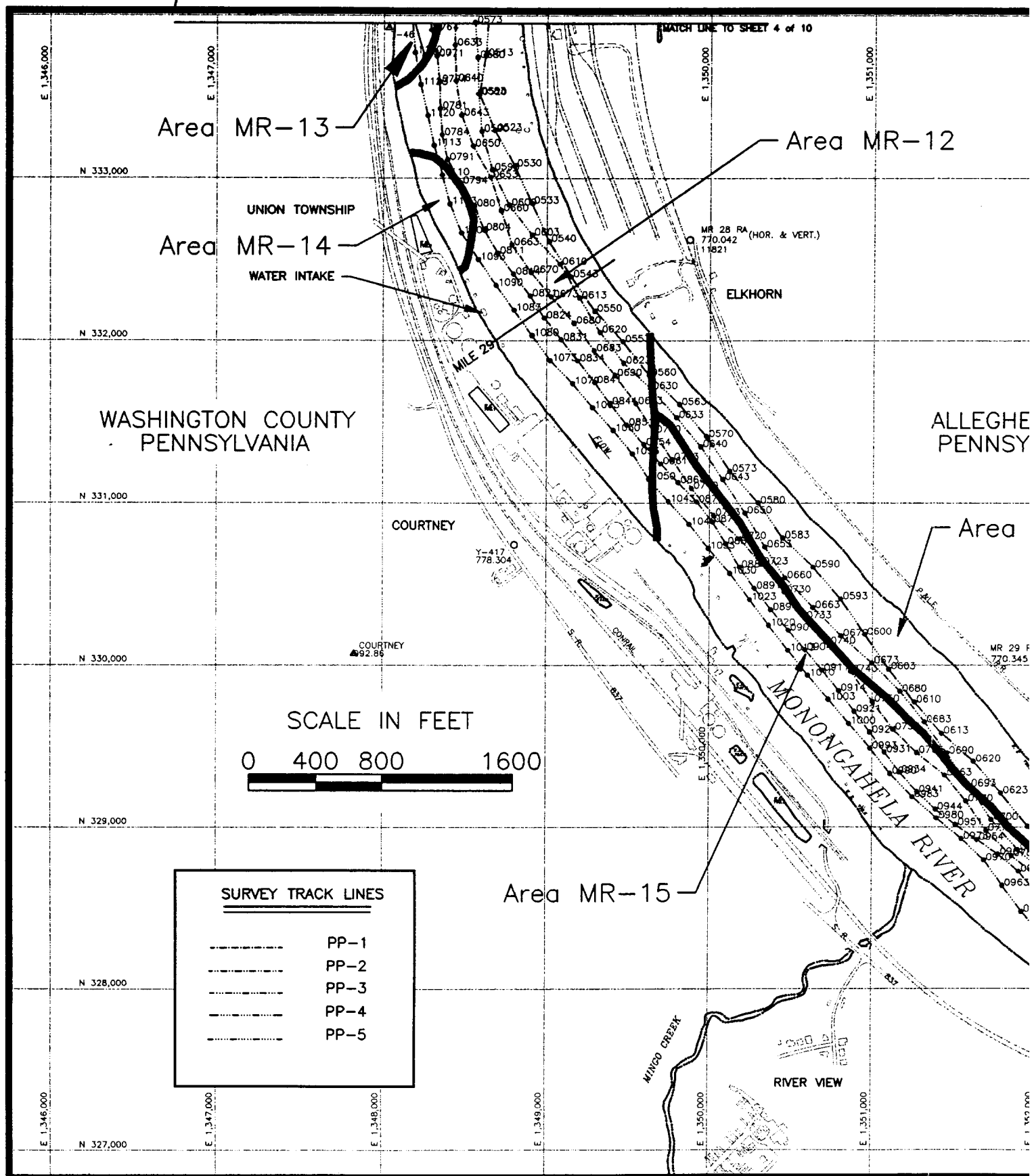


Figure 24. Geophysical interpretation showing Areas MR-13 through MR-17, Pool 3, Monongahela River

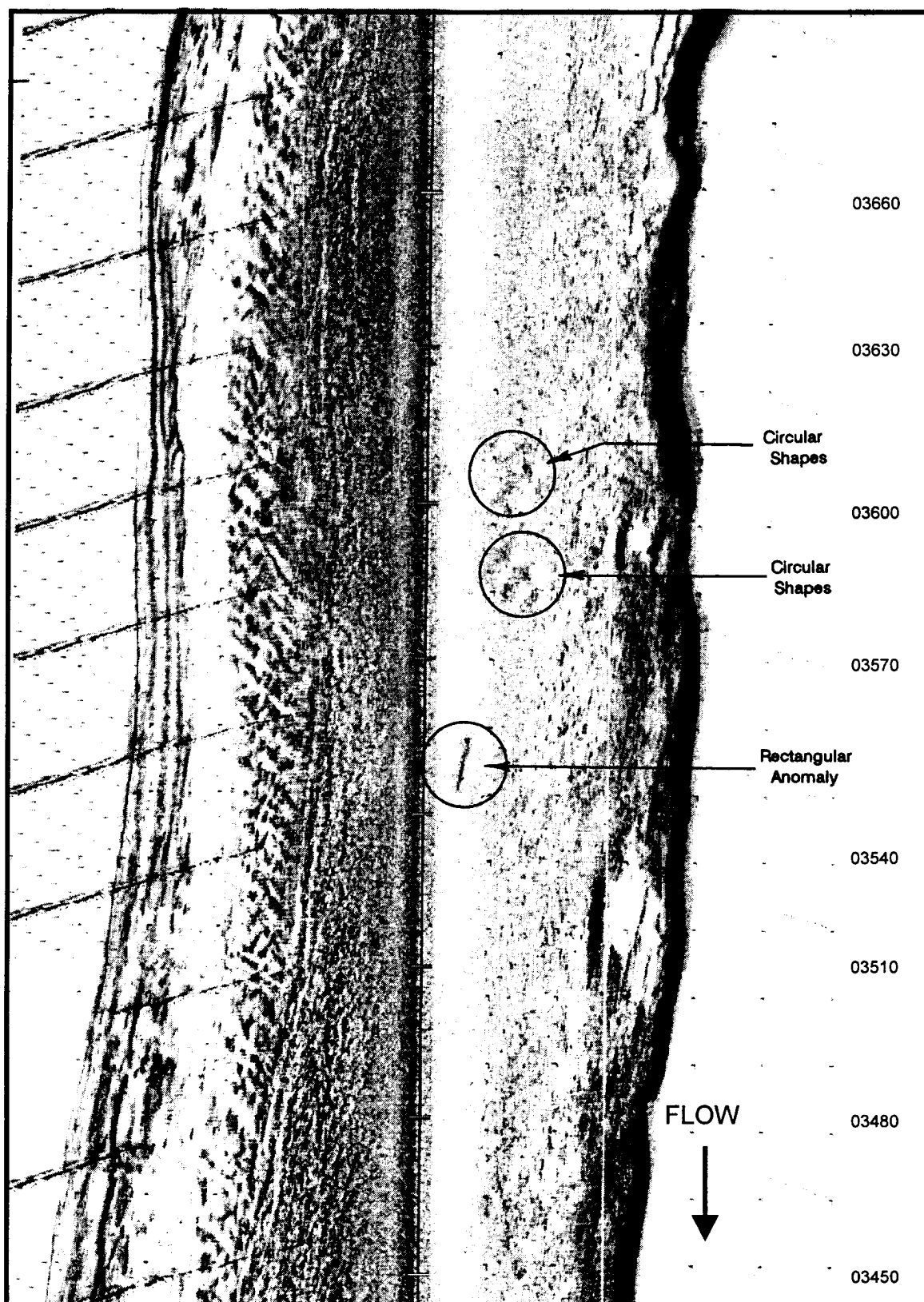


Figure 25. Side scan sonar record along survey line PP1 (fix points 3450-3660) near RM 28.2, Monongahela River

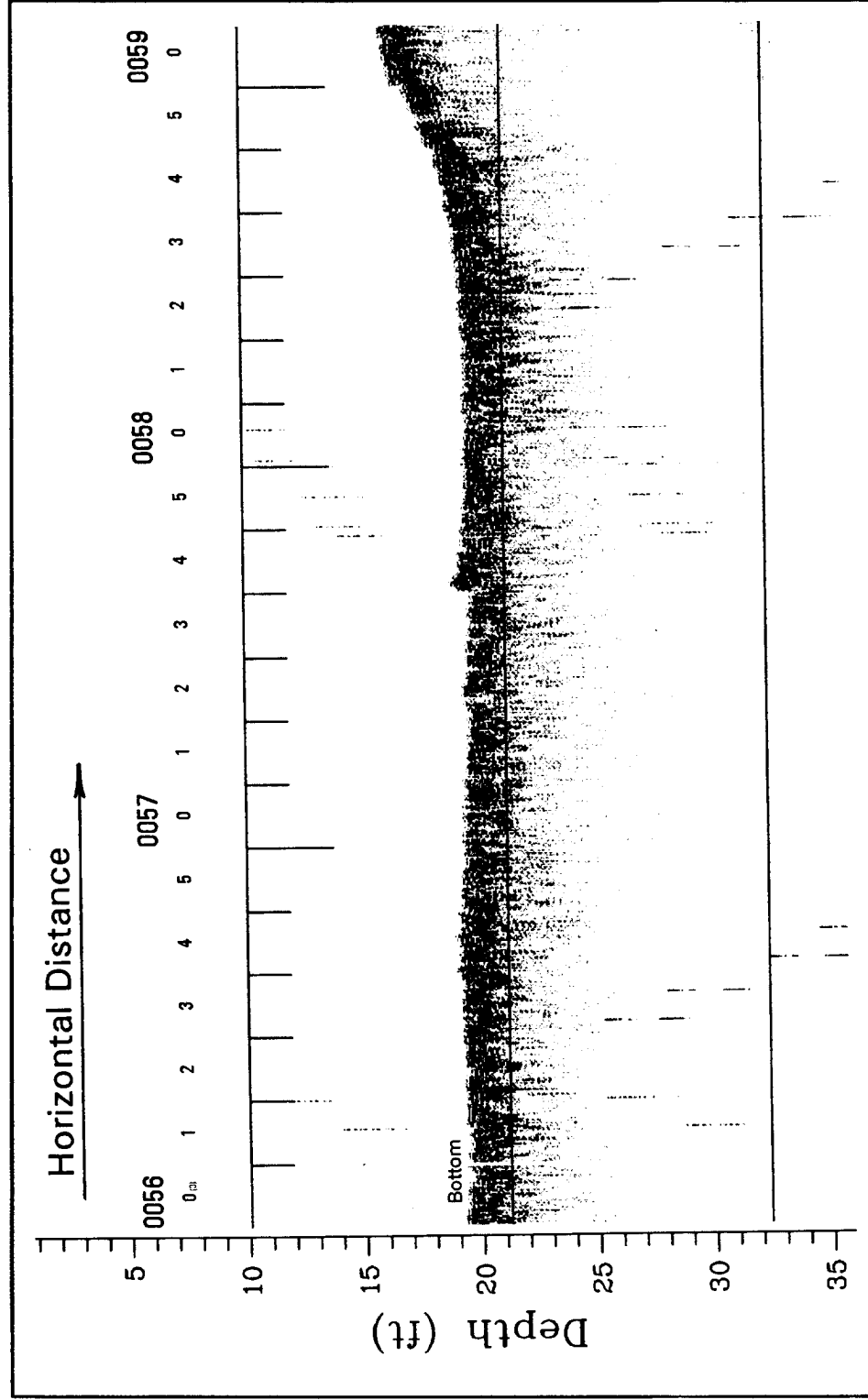


Figure 26. Subbottom seismic reflection record along survey line PP1 (files 0560-0590) near RM 28.2, Monongahela River



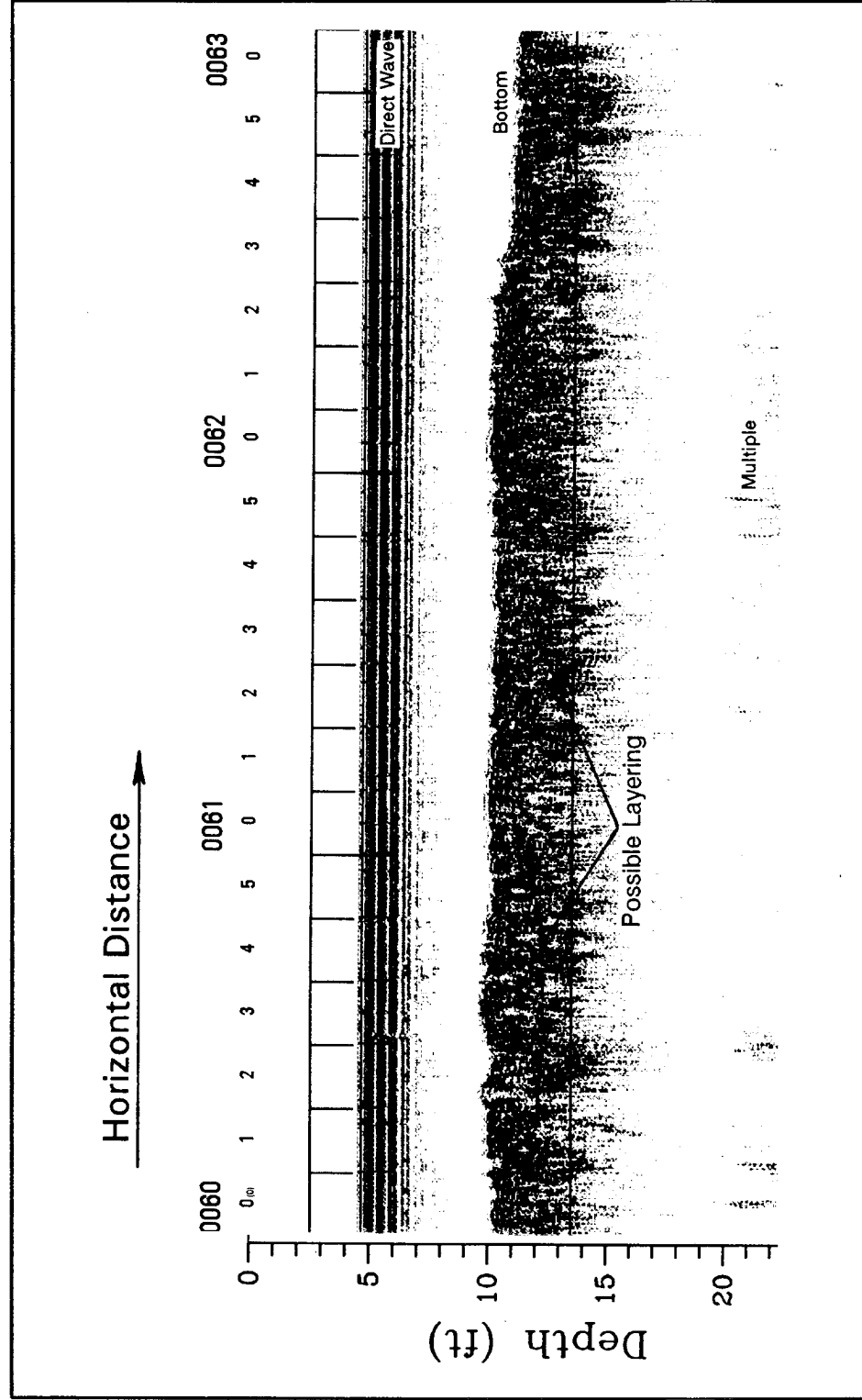


Figure 28. Subbottom seismic reflection record along survey line PP5 (files 0600-0630) near RM 29.7, Monongahela River

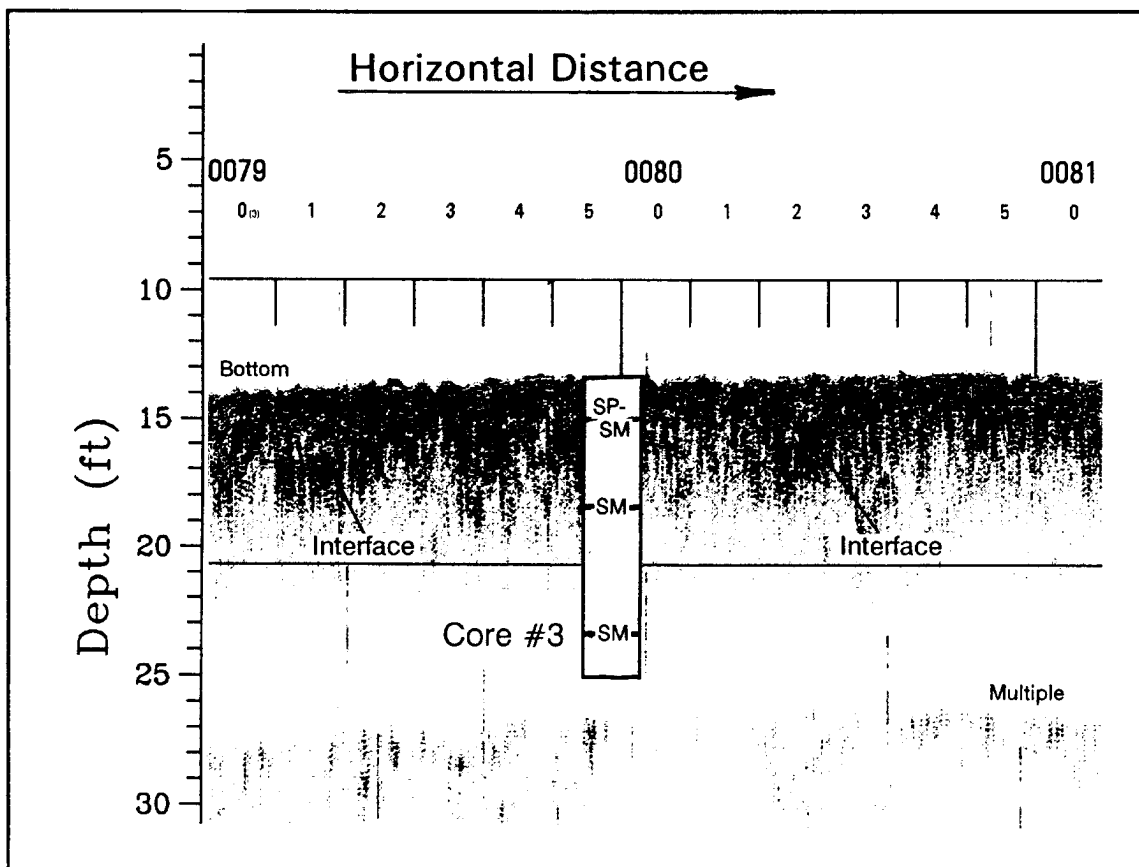


Figure 29. Subbottom seismic reflection record along survey line PP1 (files 0790-0810) near RM 30.0, Monongahela River

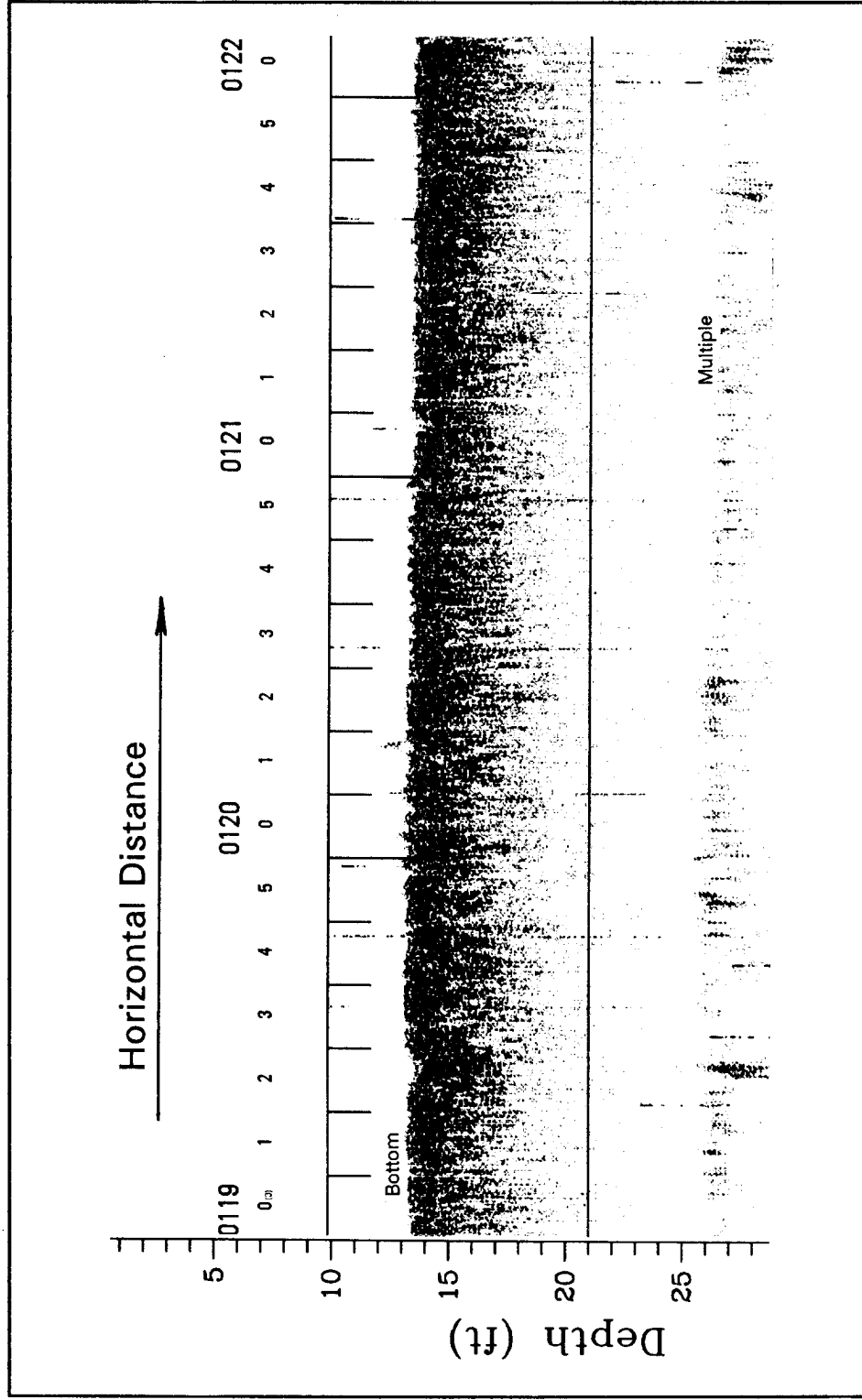
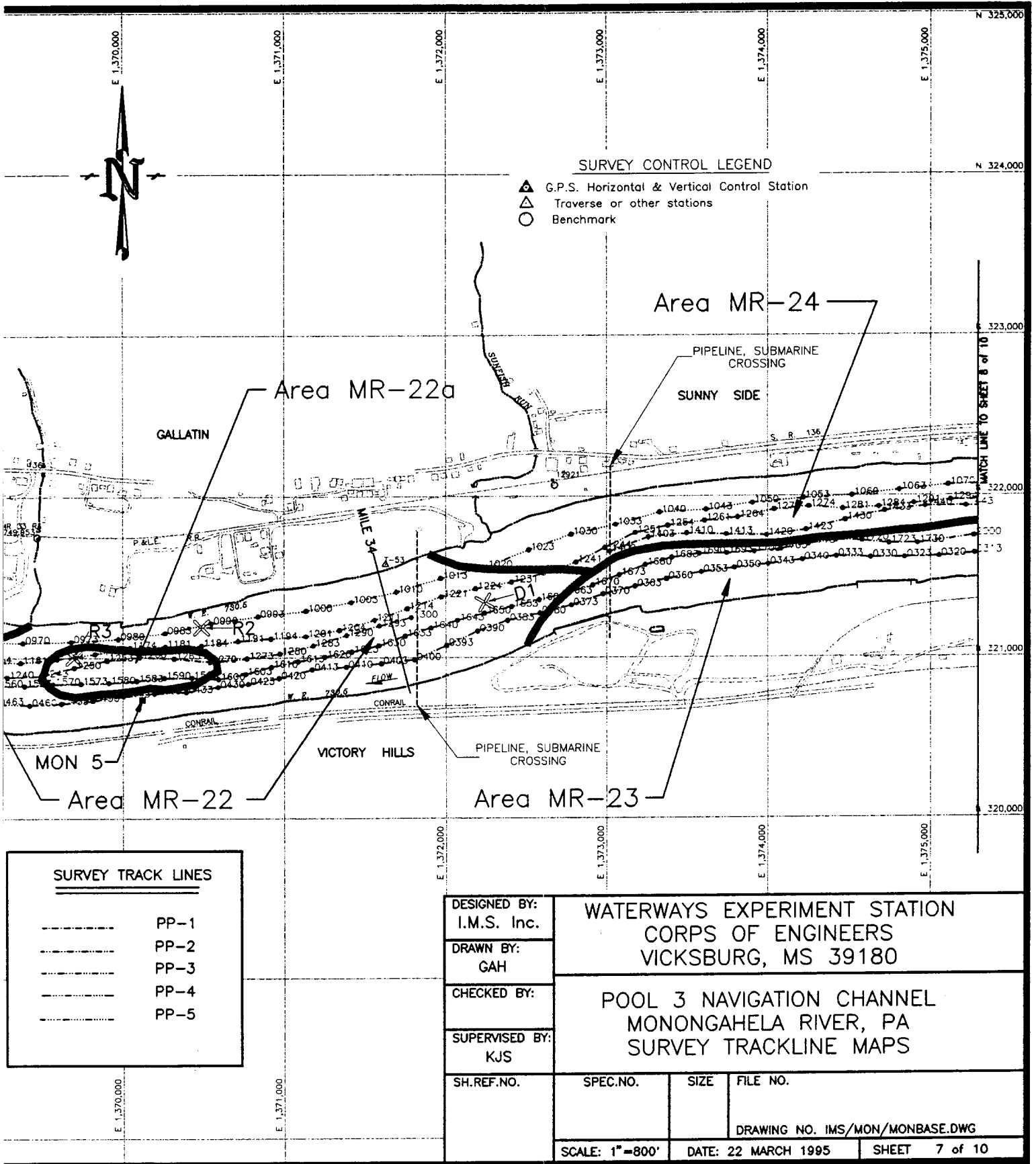


Figure 30. Subbottom seismic reflection record along survey line PP2 (files 1190-1220) near RM 31.2, Monongahela River



Figure 31. Geophysical interpretation showing Areas MR-20 through MR-24, Pool 3, Monongahela River

2



SURVEY TRACK LINES

- PP-1
- PP-2
- PP-3
- PP-4
- PP-5

DESIGNED BY:
I.M.S. Inc.

DRAWN BY:
GAH

CHECKED BY:

SUPERVISED BY:
KJS

SH.REF.NO.

WATERWAYS EXPERIMENT STATION
CORPS OF ENGINEERS
VICKSBURG, MS 39180

POOL 3 NAVIGATION CHANNEL
MONONGAHELA RIVER, PA
SURVEY TRACKLINE MAPS

SPEC.NO.

SIZE

FILE NO.

DRAWING NO. IMS/MON/MONBASE.DWG

SCALE: 1"=800'

DATE: 22 MARCH 1995

SHEET 7 of 10

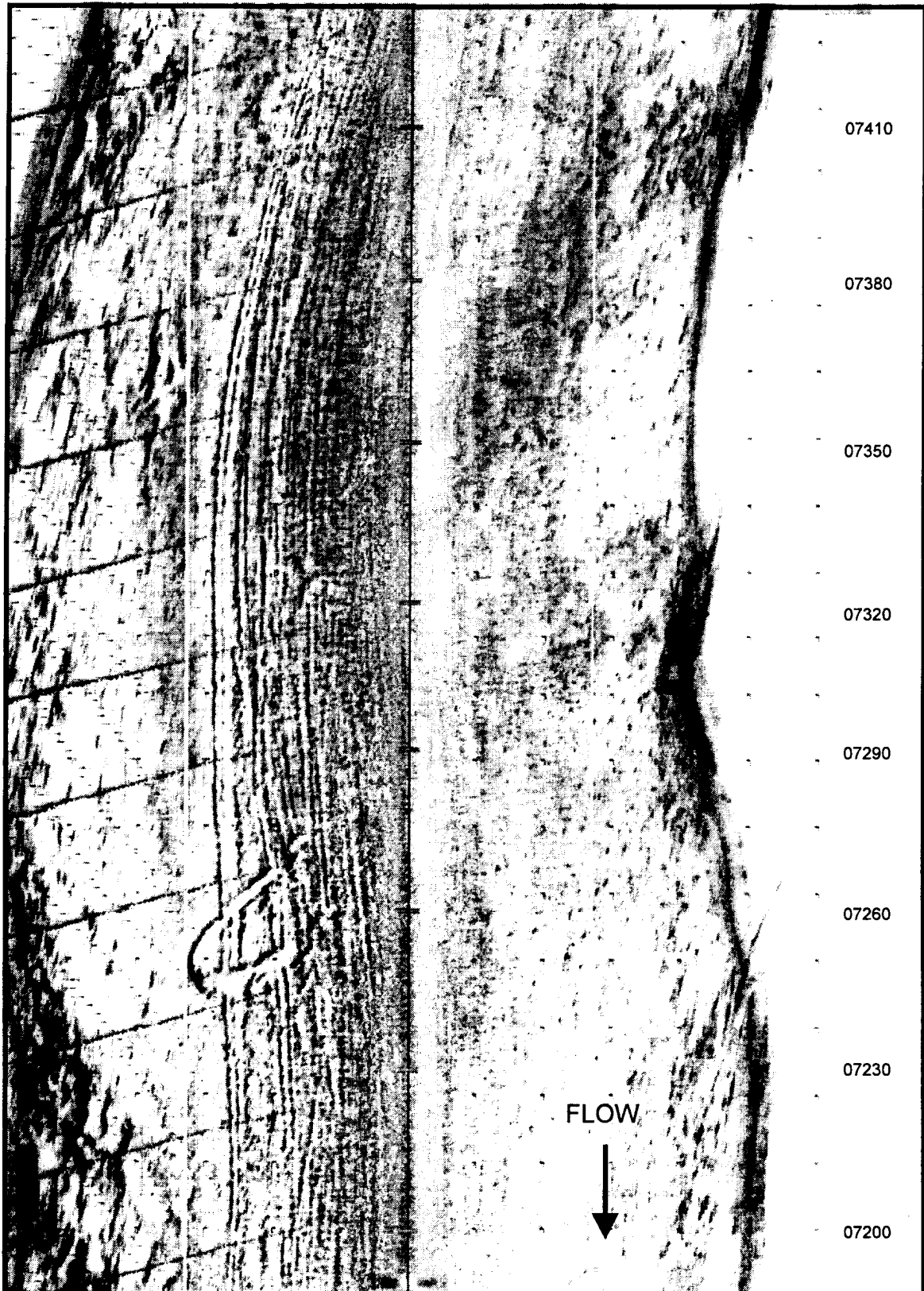


Figure 32. Side scan sonar record along survey line PP1 (fix points 7200-7410) near RM 33.0, Monongahela River

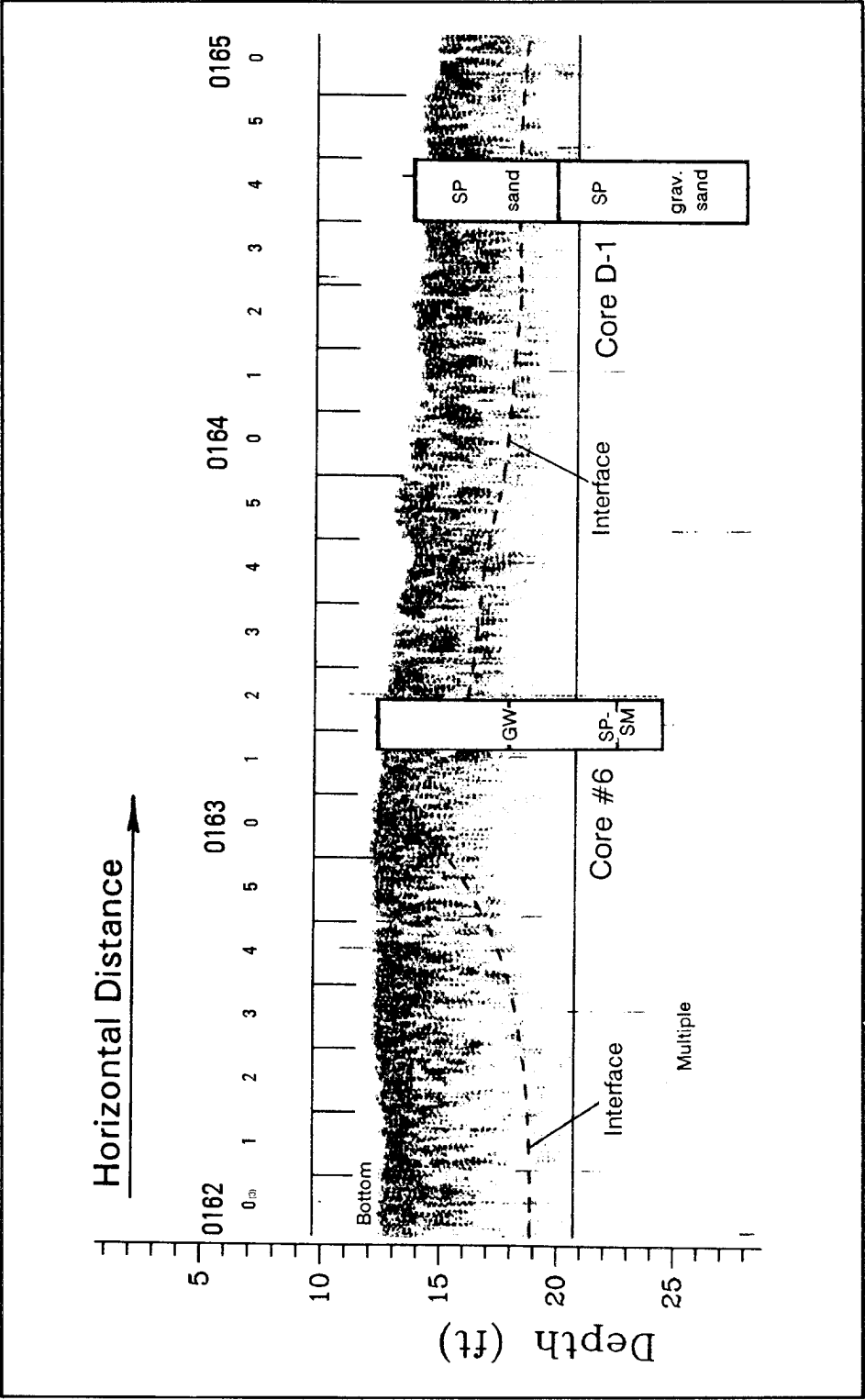


Figure 33. Subbottom seismic reflection record along survey line PP2 (files 1620-1650) near RM 34.0, Monongahela River

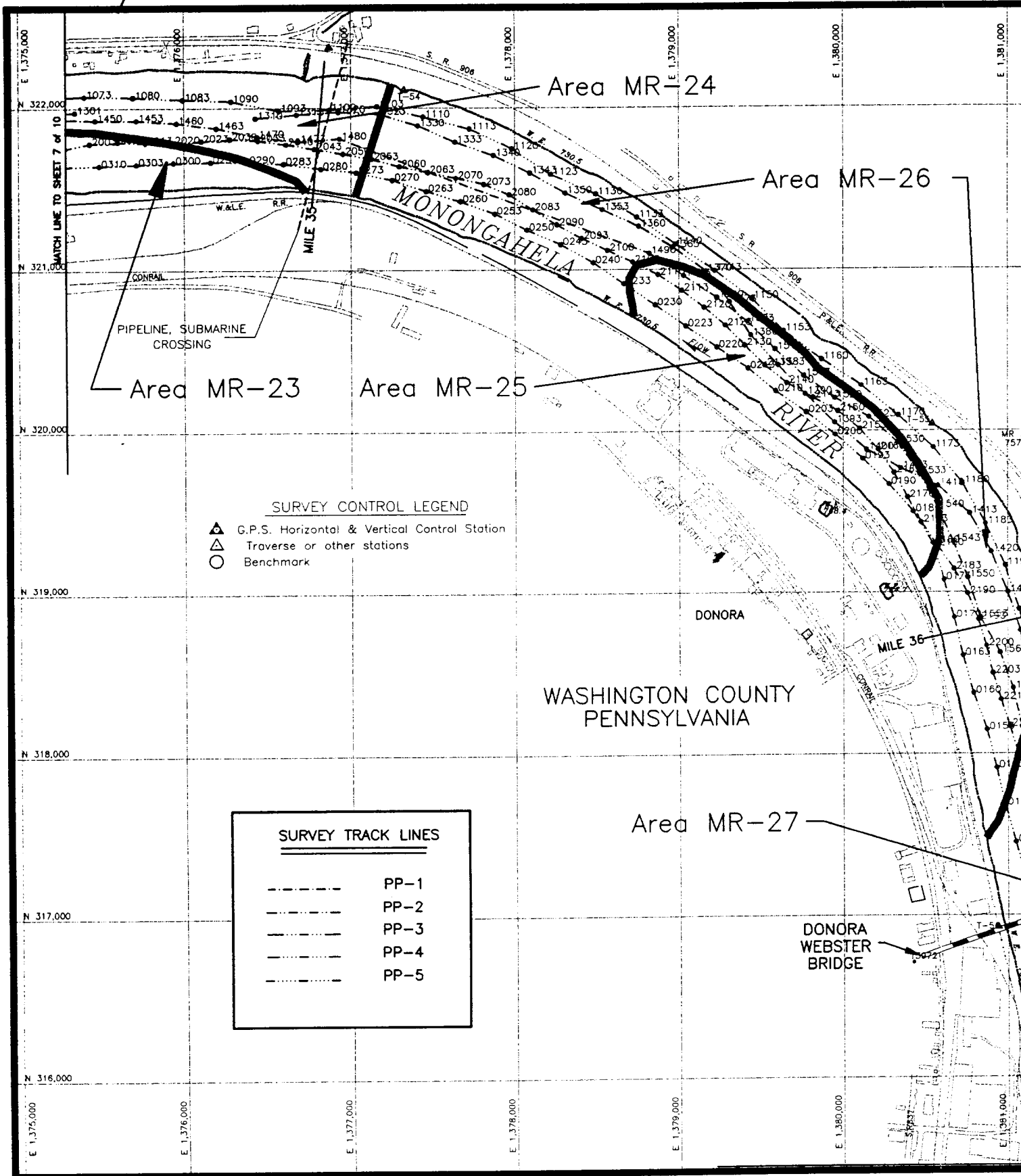
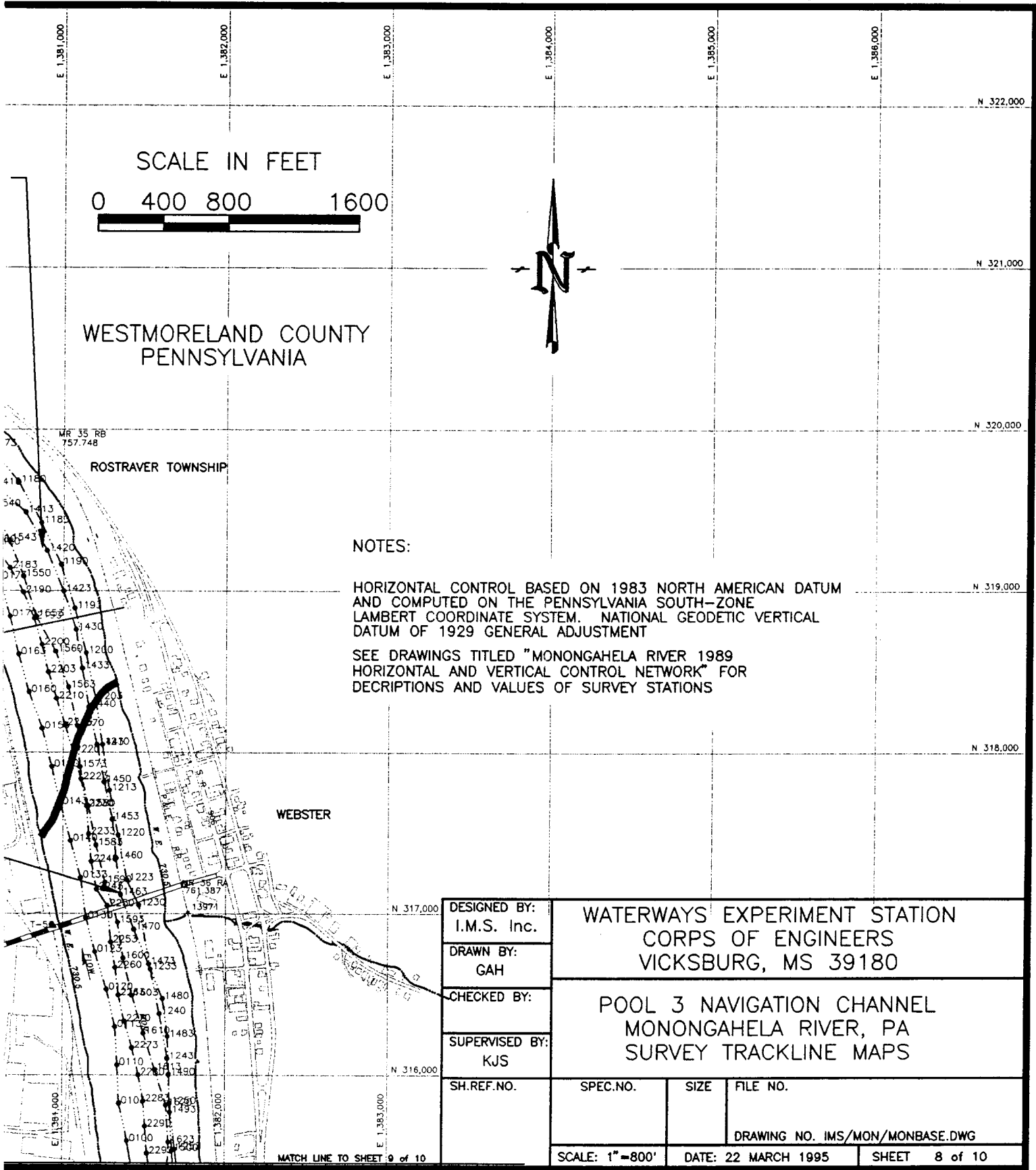
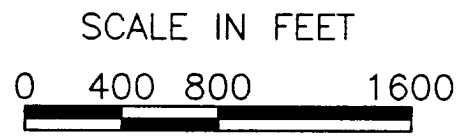


Figure 34. Geophysical interpretation showing Areas MR-23 through MR-27, Pool 3, Monongahela River

2



WESTMORELAND COUNTY
PENNSYLVANIA



NOTES:

HORIZONTAL CONTROL BASED ON 1983 NORTH AMERICAN DATUM
AND COMPUTED ON THE PENNSYLVANIA SOUTH-ZONE
LAMBERT COORDINATE SYSTEM. NATIONAL GEODETIC VERTICAL
DATUM OF 1929 GENERAL ADJUSTMENT

SEE DRAWINGS TITLED "MONONGAHELA RIVER 1989
HORIZONTAL AND VERTICAL CONTROL NETWORK" FOR
DESCRIPTORS AND VALUES OF SURVEY STATIONS

DESIGNED BY: I.M.S. Inc.	WATERWAYS EXPERIMENT STATION CORPS OF ENGINEERS VICKSBURG, MS 39180		
DRAWN BY: GAH			
CHECKED BY:	POOL 3 NAVIGATION CHANNEL MONONGAHELA RIVER, PA SURVEY TRACKLINE MAPS		
SUPERVISED BY: KJS			
SH.REF.NO.	SPEC.NO.	SIZE	FILE NO.
		DRAWING NO. IMS/MON/MONBASE.DWG	
SCALE: 1"=800'		DATE: 22 MARCH 1995	SHEET 8 of 10

MATCH LINE TO SHEET 9 of 10

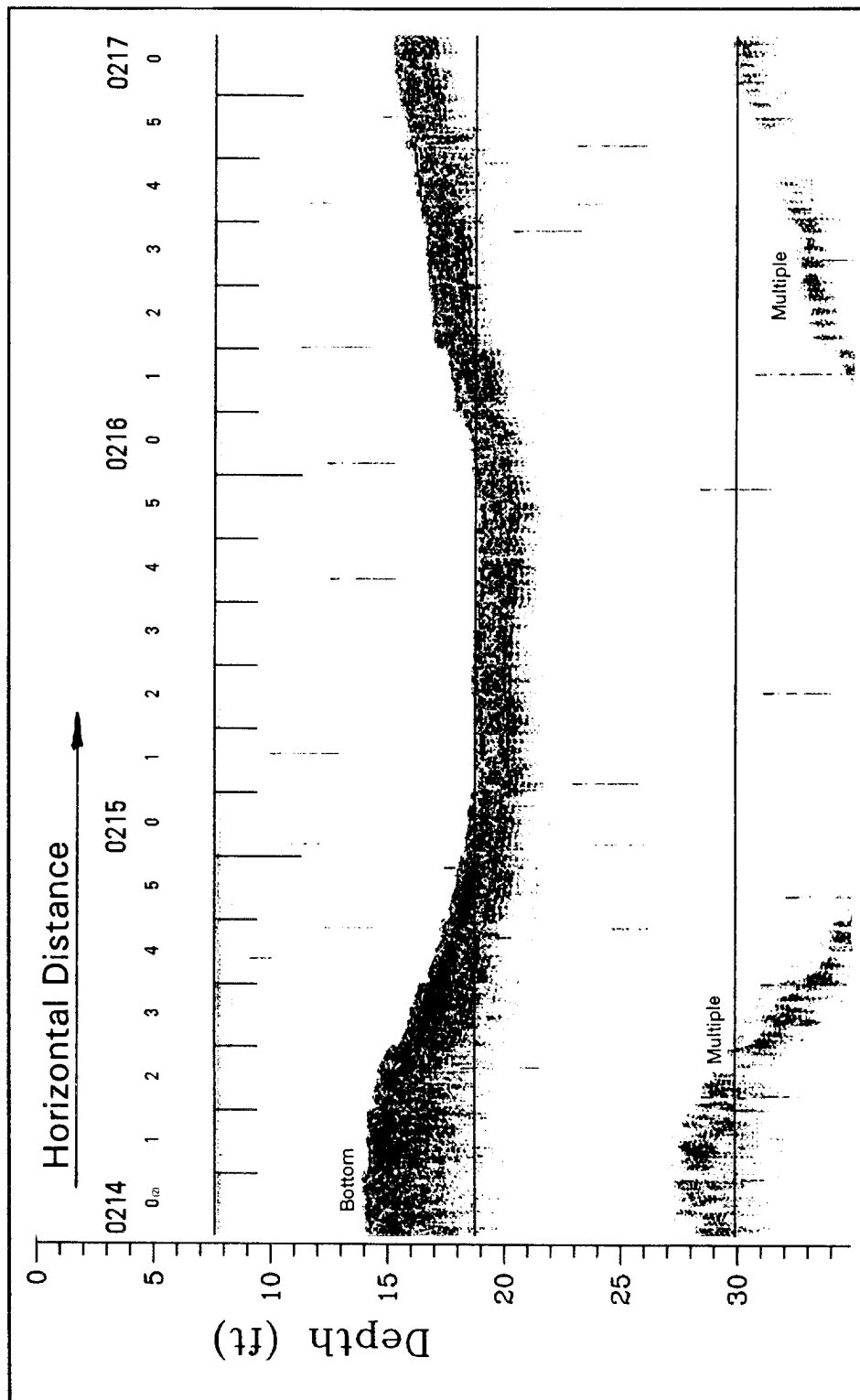


Figure 35. Subbottom seismic reflection record along survey line PP2 (files 2140-2170) near RM 35.7, Monongahela River

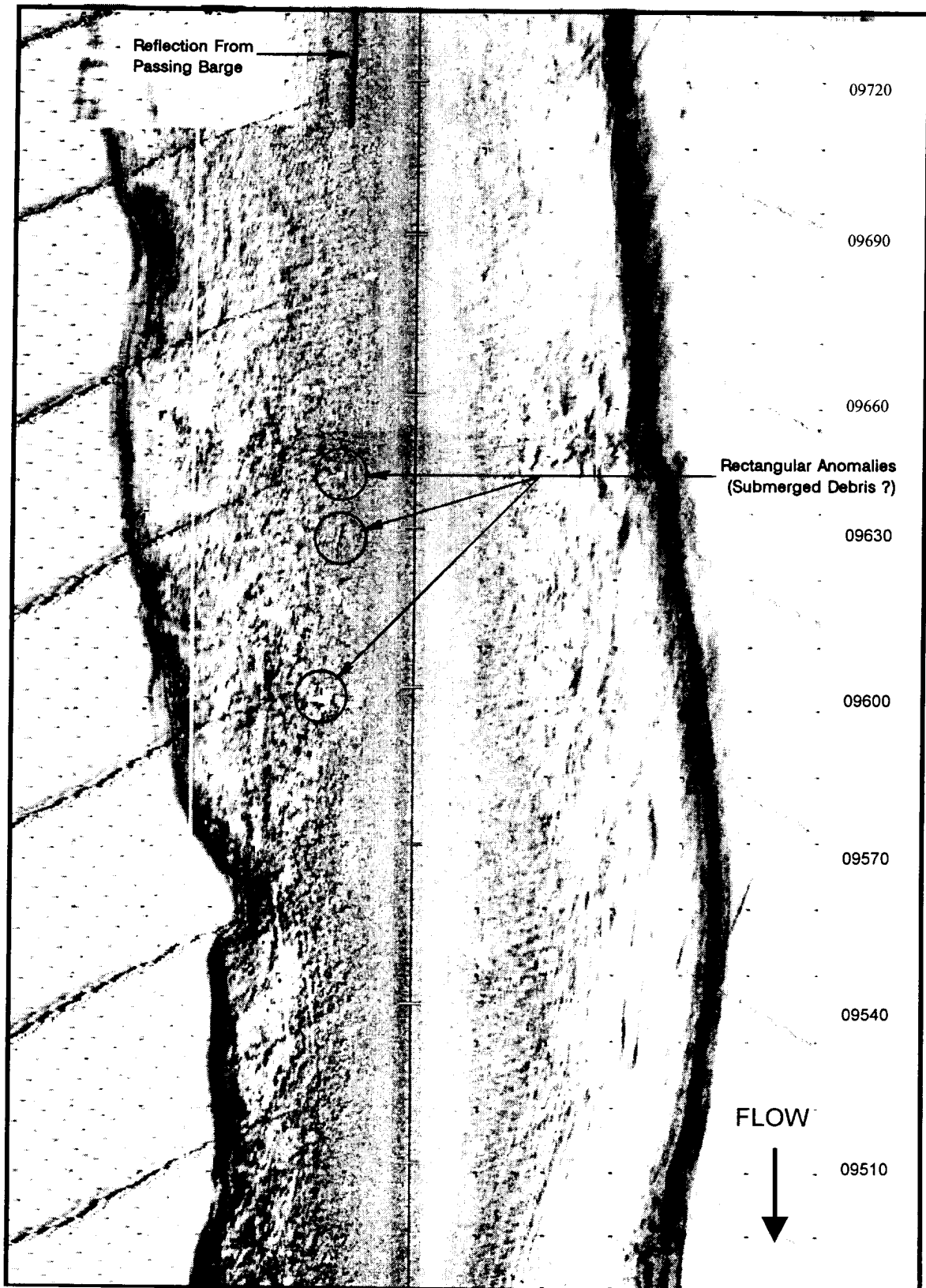
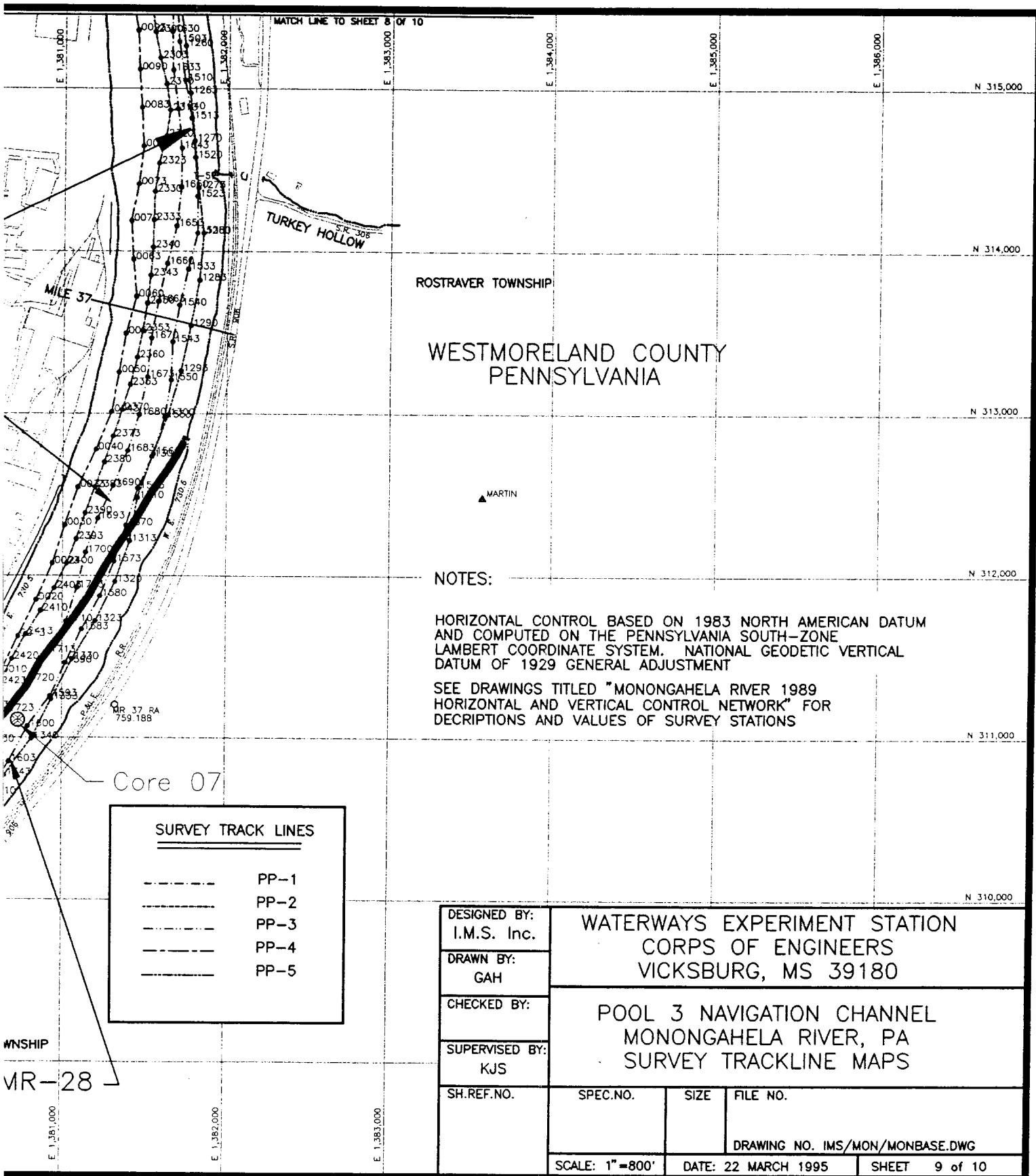


Figure 36. Side scan sonar record along survey line PP1 (fix points 9510-9720) near RM 35.7, Monongahela River



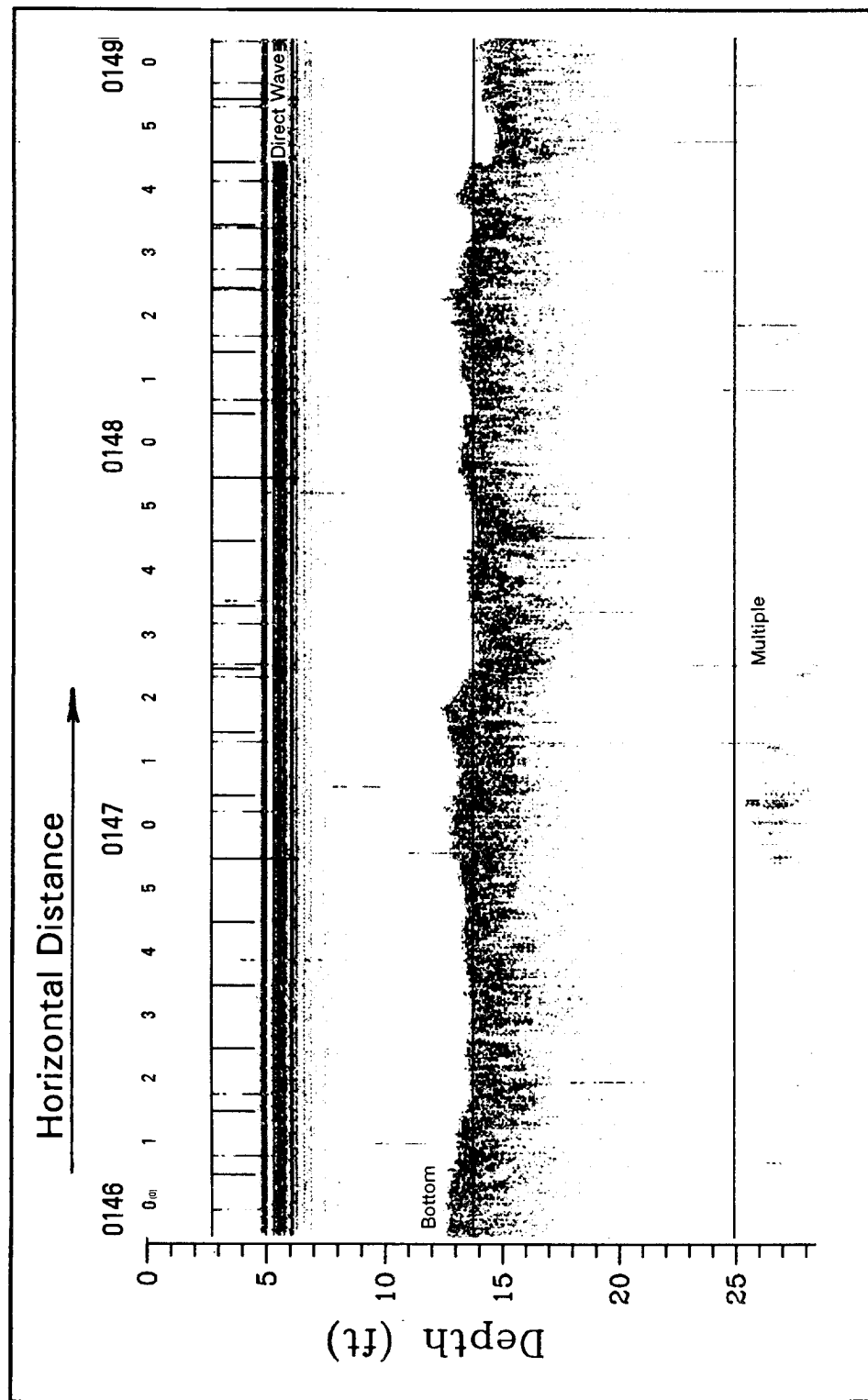


Figure 38. Subbottom seismic reflection record along survey line PP3 (files 1460-1490) near RM 36.4, Monongahela River

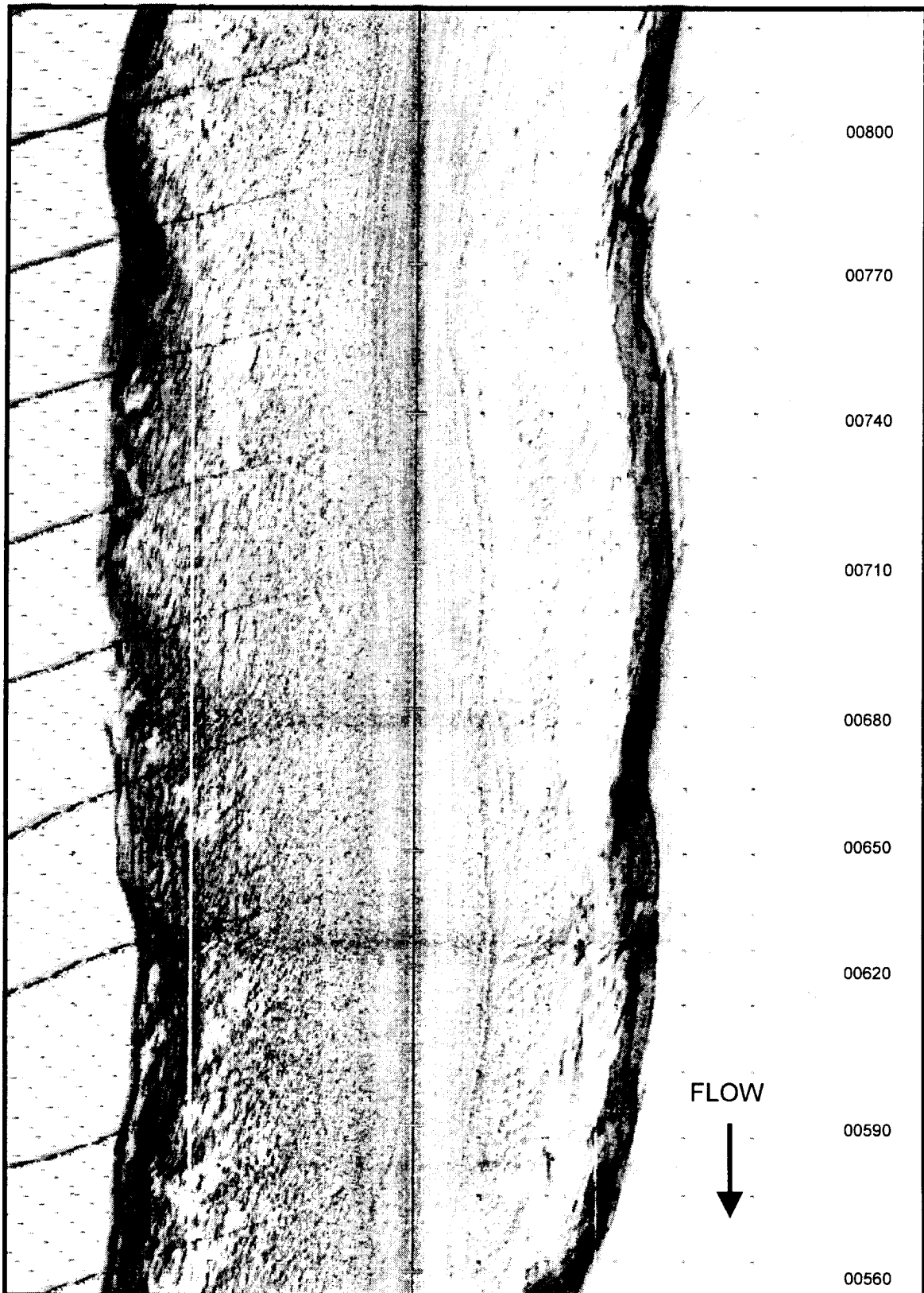
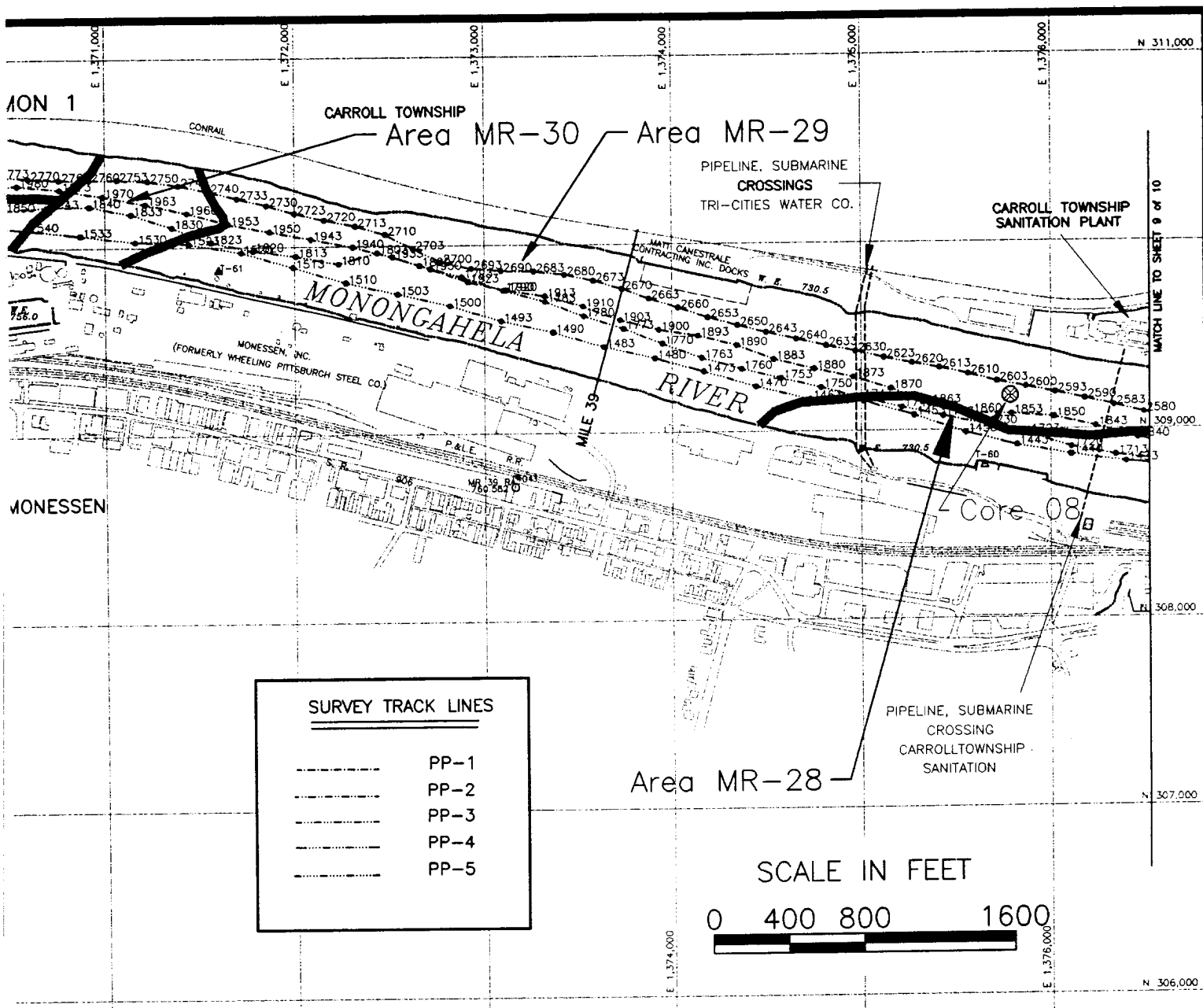


Figure 39. Side scan sonar record along survey line PP1 (fix points 0560-0800) near RM 37.0, Monongahela River



SED ON 1983 NORTH AMERICAN DATUM
PENNSYLVANIA SOUTH-ZONE
STEM. NATIONAL GEODETIC VERTICAL
ADJUSTMENT

MONONGAHELA RIVER 1989
CONTROL NETWORK FOR
OF SURVEY STATIONS

DESIGNED BY:
I.M.S. Inc.

DRAWN BY:
GAH

CHECKED BY:

SUPERVISED BY:
KJS

SH.REF.NO.

WATERWAYS EXPERIMENT STATION
CORPS OF ENGINEERS
VICKSBURG, MS 39180

POOL 3 NAVIGATION CHANNEL
MONONGAHELA RIVER, PA
SURVEY TRACKLINE MAPS

SPEC.NO.

SIZE

FILE NO.

DRAWING NO. IMS/MON/MONBASE.DWG

SCALE: 1"=800'

DATE: 22 MARCH 1995

SHEET 10 of 10

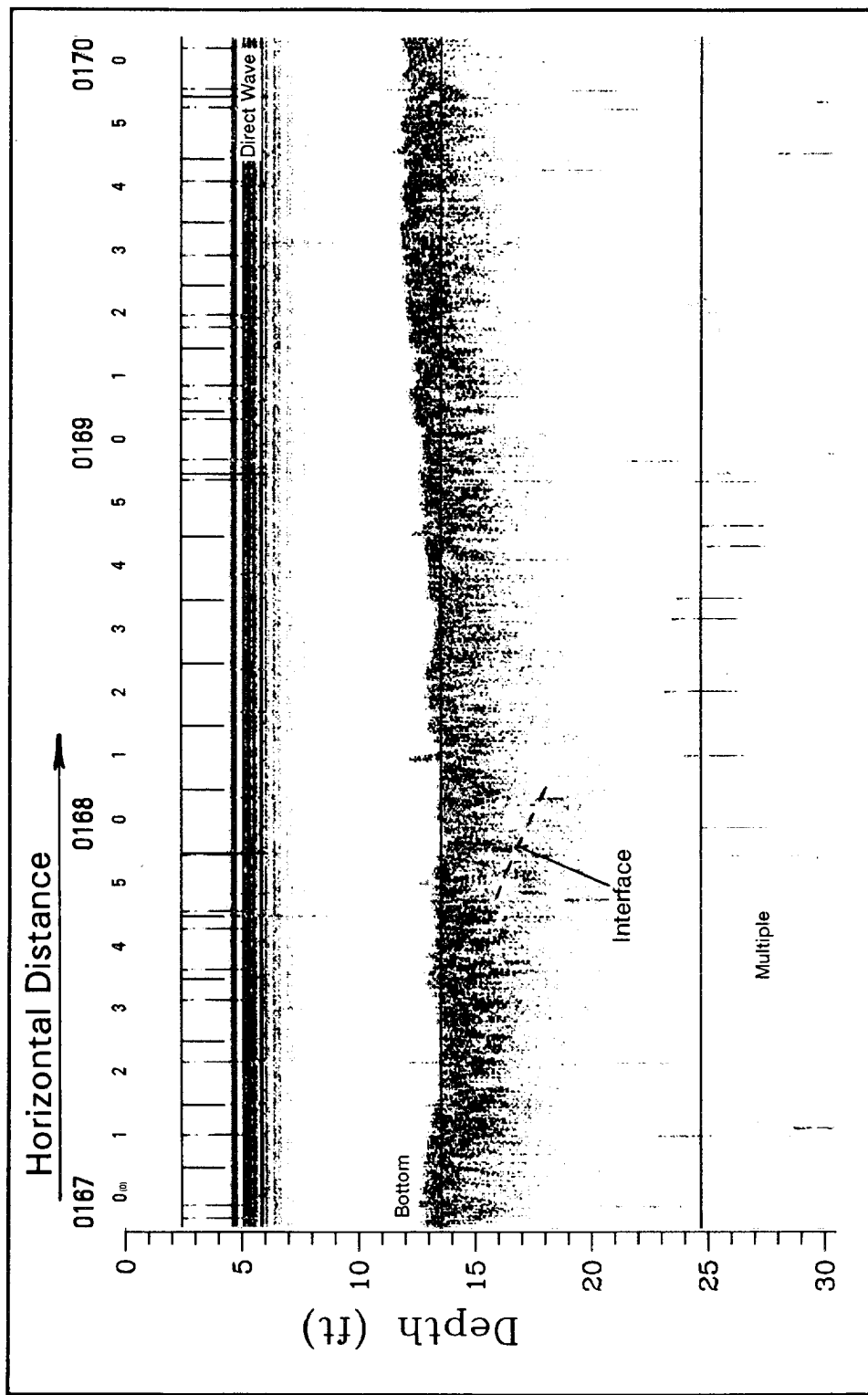


Figure 41. Subbottom seismic reflection record along survey line PP3 (files 1670-1700) near RM 38.1, Monongahela River

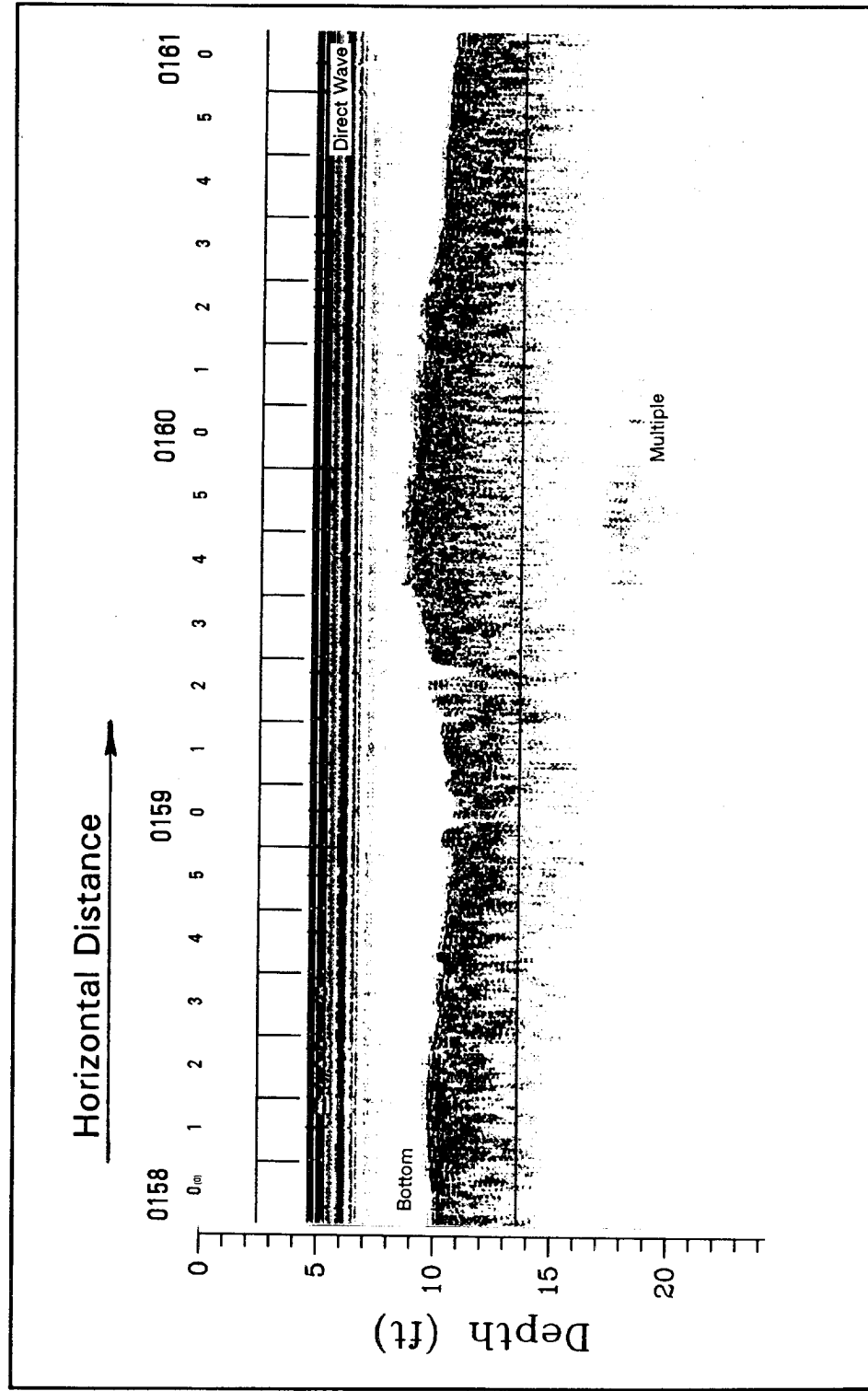


Figure 42. Subbottom seismic reflection record along survey line PP5 (files 1580-1610) near RM 40.2, Monongahela River

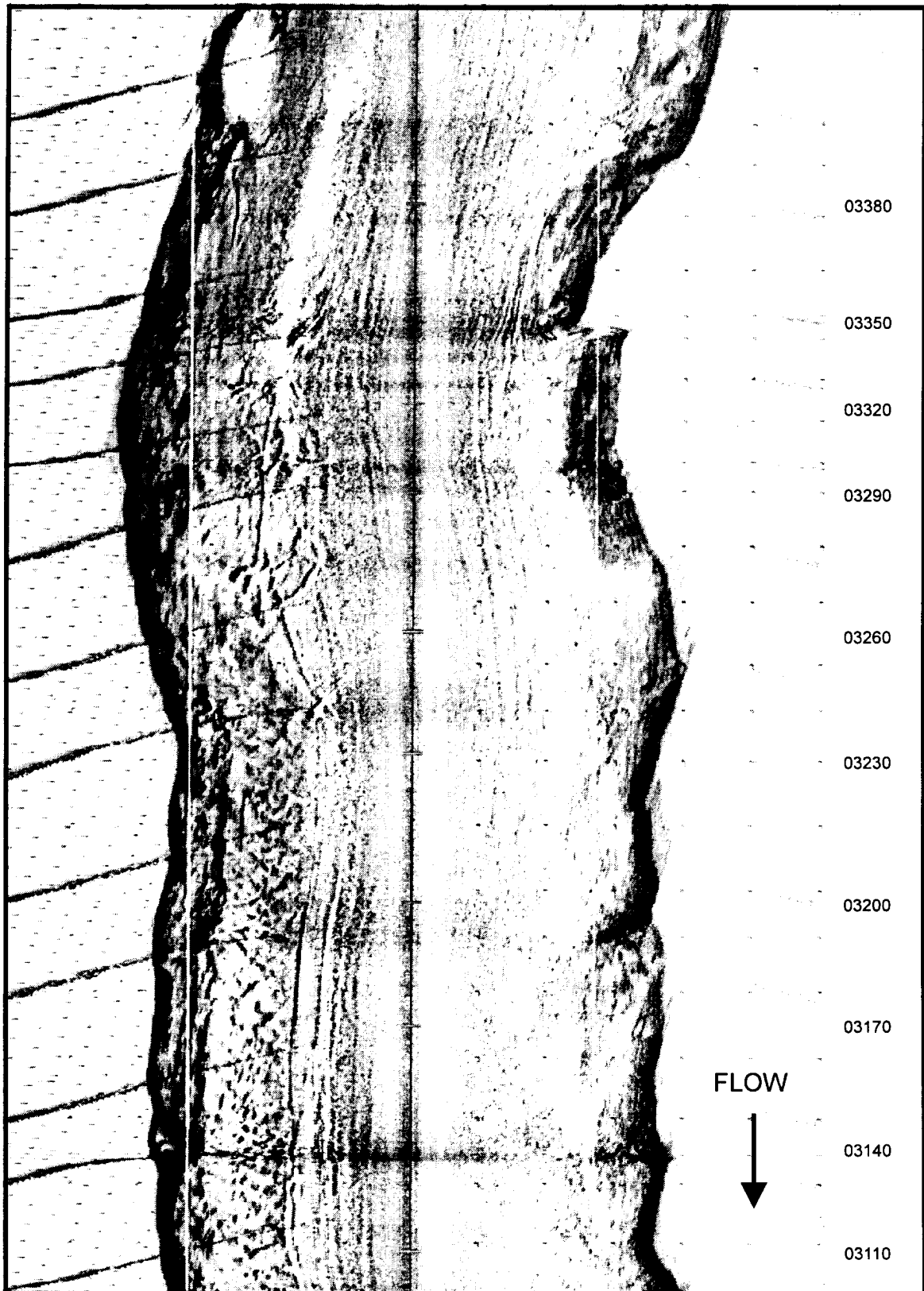


Figure 43. Side scan sonar record along survey line PP1 (fix points 3110-3380) near RM 40.3, Monongahela River

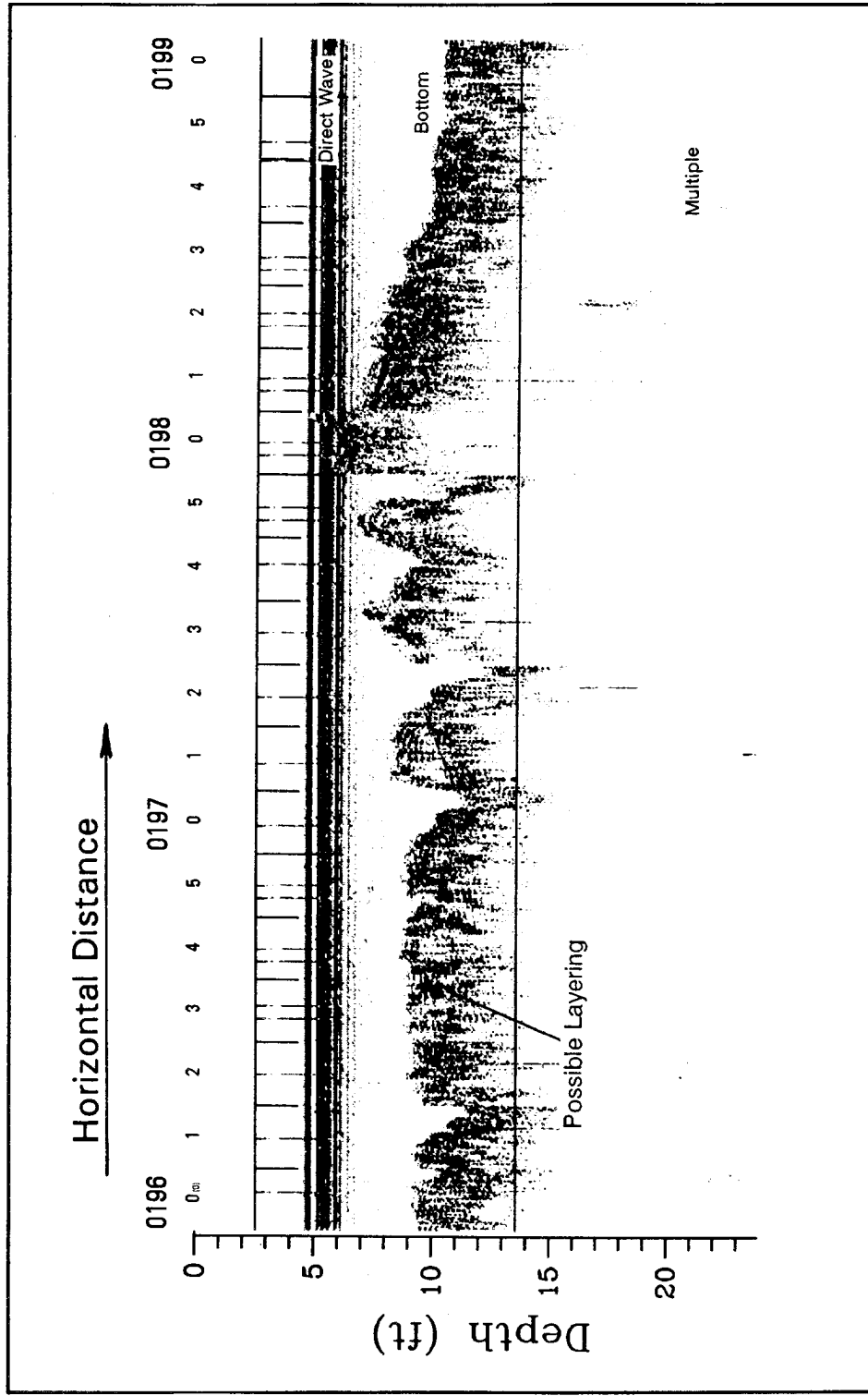


Figure 44. Subbottom seismic reflection record along survey line PP3 (files 1960-1990) near RM 40.8, Monongahela River

Appendix A

Survey Line #1

Positioning Information

**WES Survey Line #1 (centerline)
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Upstream
Survey Date/Time : 23 October 1994, 1027 to 1428 hours

Water Level Elevation : 727.4 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
0000	1367491	345805	15.1	712.3	0008
0003	1367421	345670	13.7	713.7	0039
0010	1367333	345560	13.1	714.3	0069
0013	1367216	345467	14.1	713.3	0101
0020	1367095	345382	14.7	712.7	0132
0023	1366986	345290	15.0	712.4	0162
0030	1366881	345185	14.9	712.5	0193
0033	1366777	345084	16.0	711.4	0224
0040	1366666	345001	17.0	710.4	0254
0043	1366543	344923	17.8	709.6	0285
0050	1366415	344847	18.3	709.1	0317
0053	1366300	344762	19.2	708.2	0348
0060	1366195	344652	20.2	707.2	0380
0063	1366111	344535	18.2	709.2	0411
0070	1366030	344420	17.4	710.0	0442
0073	1365934	344325	18.1	709.3	0472
0080	1365827	344237	18.4	709.0	0502
0083	1365716	344152	18.5	708.9	0532
0090	1365612	344062	17.4	710.0	0563
0093	1365514	343954	18.4	709.0	0595
0100	1365434	343840	18.9	708.5	0626
0103	1365357	343718	18.1	709.3	0658
0110	1365279	343607	18.3	709.1	0689
0113	1365176	343473	17.1	710.3	0719
0120	1365061	343311	15.1	712.3	0750
0123	1364963	343134	15.8	711.6	0781
0130	1364899	342941	13.6	713.8	0812
0133	1364839	342755	17.2	710.2	0842
0140	1364768	342563	16.5	710.9	0873
0143	1364704	342366	15.2	712.2	0903
0150	1364620	342157	14.8	712.6	0935
0153	1364495	341951	17.6	709.8	0968
0160	1364332	341811	17.0	710.4	0998
0163	1364162	341666	15.6	711.8	1029
0170	1363996	341501	15.1	712.3	1062
0173	1363858	341337	15.0	712.4	1093
0180	1363715	341157	14.6	712.8	1126
0183	1363567	341004	14.9	712.5	1157
0190	1363391	340883	15.0	712.4	1188
0193	1363208	340772	14.4	713.0	1219

**WES Survey Line #1 (centerline) cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Upstream

Survey Date/Time : 23 October 1994, 1027 to 1428 hours

Water Level Elevation : 727.4 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
0200	1363038	340654	14.3	713.1	1249
0203	1362888	340513	15.5	711.9	1279
0210	1362746	340368	15.2	712.2	1309
0213	1362587	340231	16.3	711.1	1340
0220	1362416	340119	16.4	711.0	1370
0223	1362228	340027	16.9	710.5	1401
0230	1362040	339924	15.7	711.7	1432
0233	1361856	339806	14.9	712.5	1464
0240	1361700	339679	14.7	712.7	1494
0243	1361529	339555	14.8	712.6	1526
0250	1361376	339434	14.9	712.5	1556
0253	1361195	339341	15.0	712.4	1587
0260	1361004	339276	14.4	713.0	1618
0263	1360829	339185	13.9	713.5	1648
0270	1360657	339099	14.1	713.3	1678
0273	1360463	339033	13.6	713.8	1710
0280	1360274	338962	13.7	713.7	1741
0283	1360072	338899	14.0	713.4	1774
0290	1359881	338845	14.1	713.3	1805
0293	1359684	338779	14.5	712.9	1837
0300	1359486	338699	14.7	712.7	1870
0303	1359305	338612	15.2	712.2	1901
0310	1359117	338538	15.7	711.7	1932
0313	1358919	338509	15.5	711.9	1963
0320	1358729	338519	15.1	712.3	1993
0323	1358522	338504	15.2	712.2	2025
0330	1358319	338477	15.2	712.2	2056
0333	1358127	338454	15.1	712.3	2086
0340	1357937	338439	15.5	711.9	2118
0343	1357743	338427	15.3	712.1	2149
0350	1357550	338398	16.1	711.3	2180
0353	1357347	338365	16.8	710.6	2212
0360	1357152	338321	16.7	710.7	2243
0363	1356959	338271	16.3	711.1	2274
0370	1356763	338260	16.8	710.6	2306
0373	1356572	338302	16.6	710.8	2337
0380	1356380	338354	16.4	711.0	2368
0383	1356184	338384	17.5	709.9	2399
0390	1355990	338393	16.6	710.8	2429
0393	1355790	338373	17.2	710.2	2461

**WES Survey Line #1 (centerline) cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Upstream

Survey Date/Time : 23 October 1994, 1027 to 1428 hours

Water Level Elevation : 727.4 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
0400	1355596	338311	18.0	709.4	2493
0403	1355405	338249	17.8	709.6	2524
0410	1355217	338226	18.1	709.3	2554
0413	1355017	338228	17.9	709.5	2585
0420	1354806	338241	17.2	710.2	2617
0423	1354598	338263	18.0	709.4	2650
0430	1354390	338284	18.3	709.1	2682
0433	1354183	338289	17.8	709.6	2714
0440	1353985	338277	16.5	710.9	2745
0443	1353792	338242	16.5	710.9	2776
0450	1353606	338203	16.8	710.6	2806
0453	1353418	338190	16.2	711.2	2836
0460	1353229	338190	16.7	710.7	2866
0463	1353026	338191	16.3	711.1	2898
0470	1352832	338181	17.0	710.4	2928
0473	1352630	338173	17.1	710.3	2960
0480	1352435	338152	17.8	709.6	2992
0483	1352244	338084	17.8	709.6	3024
0490	1352068	338022	16.8	710.6	3054
0493	1351872	337959	16.6	710.8	3086
0500	1351689	337887	15.5	711.9	3117
0503	1351510	337798	14.9	712.5	3149
0510	1351342	337702	14.9	712.5	3180
0513	1351144	337623	13.8	713.6	3211
0520	1350935	337556	14.8	712.6	3243
0523	1350738	337506	16.3	711.1	3275
0530	1350569	337477	16.8	710.6	3307
0533	1350400	337376	18.5	708.9	3338
0540	1350212	337261	19.1	708.3	3370
0543	1350036	337150	19.3	708.1	3402
0550	1349882	337023	19.7	707.7	3435
0553	1349734	336877	19.6	707.8	3468
0560	1349524	336618	19.1	708.3	3522
0563	1349404	336469	18.8	708.6	3553
0570	1349265	336310	19.0	708.4	3586
0573	1349136	336156	19.5	707.9	3618
0580	1349019	335999	19.2	708.2	3649
0583	1348918	335817	18.6	708.8	3682
0590	1348848	335621	15.5	711.9	3715
0593	1348783	335438	15.1	712.3	3746

**WES Survey Line #1 (centerline) cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Upstream

Survey Date/Time : 23 October 1994, 1027 to 1428 hours

Water Level Elevation : 727.4 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
0600	1348677	335274	17.7	709.7	3777
0603	1348606	335091	17.3	710.1	3810
0610	1348544	334885	16.9	710.5	3843
0613	1348491	334673	16.6	710.8	3876
0620	1348446	334465	17.7	709.7	3909
0623	1348438	334246	17.1	710.3	3942
0630	1348434	334028	16.9	710.5	3975
0633	1348436	333818	17.4	710.0	4008
0640	1348443	333598	17.4	710.0	4041
0643	1348478	333387	18.3	709.1	4074
0650	1348548	333198	18.4	709.0	4105
0653	1348656	333007	17.7	709.7	4137
0660	1348723	332800	18.1	709.3	4169
0663	1348788	332591	18.4	709.0	4202
0670	1348906	332421	18.1	709.3	4233
0673	1349028	332271	17.7	709.7	4264
0680	1349168	332108	16.6	710.8	4297
0683	1349292	331938	16.8	710.6	4330
0690	1349420	331787	16.4	711.0	4360
0693	1349548	331613	16.5	710.9	4392
0700	1349659	331439	16.1	711.3	4423
0703	1349770	331267	15.7	711.7	4454
0710	1349889	331090	16.0	711.4	4486
0713	1350025	330924	15.0	712.4	4518
0720	1350186	330780	14.4	713.0	4549
0723	1350320	330622	13.9	713.5	4580
0730	1350461	330450	14.1	713.3	4613
0733	1350587	330289	13.5	713.9	4643
0740	1350734	330133	12.4	715.0	4675
0743	1350868	329960	12.2	715.2	4707
0750	1351002	329774	12.4	715.0	4739
0753	1351128	329601	12.5	714.9	4771
0760	1351274	329458	12.6	714.8	4802
0763	1351447	329319	12.7	714.7	4835
0770	1351575	329159	13.3	714.1	4866
0773	1351698	328978	13.7	713.7	4899
0780	1351852	328820	13.9	713.5	4931
0783	1352024	328679	14.0	713.4	4964
0790	1352169	328536	14.0	713.4	4995
0793	1352324	328400	13.8	713.6	5026

**WES Survey Line #1 (centerline) cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Upstream

Survey Date/Time : 23 October 1994, 1027 to 1428 hours

Water Level Elevation : 727.4 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
0800	1352495	328271	13.0	714.4	5058
0803	1352689	328174	13.2	714.2	5091
0810	1352876	328091	13.4	714.0	5122
0813	1353062	328001	12.6	714.8	5153
0820	1353271	327922	13.0	714.4	5186
0823	1353476	327859	12.8	714.6	5217
0830	1353694	327810	13.0	714.4	5250
0833	1353909	327784	14.0	713.4	5282
0840	1354121	327741	12.3	715.1	5314
0843	1354319	327654	13.1	714.3	5346
0850	1354519	327552	13.3	714.1	5379
0853	1354726	327477	13.0	714.4	5411
0860	1354948	327469	14.0	713.4	5443
0863	1355168	327444	14.1	713.3	5476
0870	1355386	327372	14.7	712.7	5509
0873	1355599	327280	15.4	712.0	5542
0880	1355798	327198	15.5	711.9	5573
0883	1356009	327134	16.3	711.1	5605
0890	1356218	327059	15.6	711.8	5637
0893	1356416	326972	14.9	712.5	5668
0900	1356634	326893	14.3	713.1	5701
0903	1356838	326862	14.8	712.6	5731
0910	1357064	326855	15.2	712.2	5764
0913	1357280	326815	14.9	712.5	5796
0920	1357489	326740	14.7	712.7	5828
0923	1357703	326662	14.4	713.0	5861
0930	1357905	326585	13.6	713.8	5892
0933	1358121	326509	12.7	714.7	5925
0940	1358322	326437	13.1	714.3	5956
0943	1358542	326371	13.0	714.4	5989
0950	1358764	326310	13.1	714.3	6022
0953	1358989	326261	13.1	714.3	6055
0960	1359198	326193	14.1	713.3	6087
0963	1359392	326101	14.3	713.1	6119
0970	1359590	326012	14.0	713.4	6151
0973	1359778	325920	14.2	713.2	6182
0980	1359965	325825	14.1	713.3	6213
0983	1360154	325723	14.2	713.2	6245
0990	1360345	325610	15.5	711.9	6278
0993	1360524	325496	14.1	713.3	6310

**WES Survey Line #1 (centerline) cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Upstream

Survey Date/Time : 23 October 1994, 1027 to 1428 hours

Water Level Elevation : 727.4 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
1000	1360694	325386	14.1	713.3	6340
1003	1360872	325273	12.8	714.6	6371
1010	1361040	325164	12.4	715.0	6401
1013	1361222	325048	11.6	715.8	6433
1020	1361416	324937	12.0	715.4	6466
1023	1361596	324825	11.6	715.8	6498
1030	1361725	324666	11.6	715.8	6529
1033	1361831	324481	11.9	715.5	6561
1040	1361968	324315	11.7	715.7	6593
1043	1362124	324178	10.5	716.9	6624
1050	1362280	324038	11.5	715.9	6655
1053	1362413	323884	11.6	715.8	6685
1060	1362565	323726	11.6	715.8	6717
1070	1362808	323378	11.6	715.8	6780
1073	1362945	323215	11.4	716.0	6812
1080	1363106	323085	11.4	716.0	6843
1083	1363290	322963	11.2	716.2	6876
1090	1363462	322837	10.6	716.8	6908
1093	1363608	322687	11.3	716.1	6939
1100	1363775	322572	11.3	716.1	6970
1103	1363970	322496	11.1	716.3	7001
1110	1364162	322425	10.8	716.6	7031
1113	1364360	322335	10.8	716.6	7063
1120	1364542	322210	11.3	716.1	7096
1123	1364714	322097	11.8	715.6	7126
1130	1364908	322015	11.7	715.7	7157
1133	1365116	321957	11.6	715.8	7189
1140	1365304	321898	11.7	715.7	7219
1143	1365494	321828	11.7	715.7	7250
1150	1365674	321747	12.3	715.1	7280
1153	1365857	321663	12.7	714.7	7311
1160	1366054	321592	12.7	714.7	7343
1163	1366251	321544	12.4	715.0	7374
1170	1366448	321515	11.7	715.7	7404
1173	1366661	321498	11.6	715.8	7436
1180	1366873	321462	11.1	716.3	7468
1183	1367075	321407	12.4	715.0	7499
1190	1367265	321333	13.0	714.4	7529
1193	1367454	321238	13.2	714.2	7560

**WES Survey Line #1 (centerline) cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Upstream

Survey Date/Time : 23 October 1994, 1027 to 1428 hours

Water Level Elevation : 727.4 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
1200	1367655	321154	13.5	713.9	7592
1203	1367845	321092	14.8	712.6	7622
1210	1368057	321054	16.3	711.1	7654
1213	1368260	321046	15.5	711.9	7684
1220	1368471	321046	14.7	712.7	7715
1223	1368688	321017	16.1	711.3	7747
1230	1368889	320968	16.5	710.9	7778
1233	1369090	320914	16.9	710.5	7809
1240	1369292	320880	16.4	711.0	7839
1243	1369497	320887	17.3	710.1	7869
1250	1369698	320939	16.9	710.5	7900
1253	1369900	320984	17.2	710.2	7930
1260	1370105	321004	18.1	709.3	7960
1263	1370316	320995	18.6	708.8	7991
1270	1370539	320974	16.3	711.1	8023
1273	1370768	320995	15.6	711.8	8056
1280	1370973	321024	14.2	713.2	8086
1283	1371179	321074	13.4	714.0	8117
1290	1371387	321138	12.9	714.5	8149
1293	1371589	321197	12.8	714.6	8180
1300	1371787	321249	13.1	714.3	8210
1400	1373018	321658	13.9	713.5	8403
1403	1373259	321745	13.9	713.5	8440
1410	1373496	321768	13.1	714.3	8475
1413	1373743	321761	13.1	714.3	8511
1420	1373992	321754	12.6	714.8	8547
1423	1374238	321787	13.3	714.1	8583
1430	1374479	321849	13.8	713.6	8619
1433	1374721	321904	13.8	713.6	8655
1440	1374969	321932	13.8	713.6	8691
1443	1375216	321934	14.2	713.2	8727
1450	1375466	321927	13.3	714.1	8763
1453	1375713	321926	14.3	713.1	8799
1460	1375955	321909	12.5	714.9	8835
1463	1376196	321877	12.5	714.9	8871
1470	1376437	321824	11.9	715.5	8907
1473	1376684	321794	12.7	714.7	8943
1480	1376932	321811	14.4	713.0	8979
1490	1378820	321102	17.4	710.0	9281
1493	1379030	320961	16.8	710.6	9317

**WES Survey Line #1 (centerline) cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Upstream

Survey Date/Time : 23 October 1994, 1027 to 1428 hours

Water Level Elevation : 727.4 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
1500	1379232	320826	19.0	708.4	9353
1503	1379418	320678	18.3	709.1	9388
1510	1379586	320506	19.9	707.5	9424
1513	1379760	320343	18.8	708.6	9460
1520	1379950	320203	19.4	708.0	9496
1523	1380156	320085	18.6	708.8	9532
1530	1380332	319927	18.4	709.0	9568
1533	1380466	319732	18.1	709.3	9604
1540	1380576	319523	16.5	710.9	9640
1543	1380673	319312	15.6	711.8	9675
1550	1380760	319092	15.2	712.2	9711
1553	1380837	318843	13.7	713.7	9747
1560	1380955	318625	10.5	716.9	9783
1563	1381033	318404	11.0	716.4	9819
1570	1381087	318164	11.5	715.9	9855
1573	1381104	317911	11.9	715.5	9891
1580	1381156	317668	12.4	715.0	9927
1583	1381204	317426	12.8	714.6	9963
1590	1381260	317195	13.5	713.9	9999
1593	1381338	316947	13.8	713.6	0035
1600	1381373	316726	13.8	713.6	0071
1603	1381427	316494	14.0	713.4	0107
1610	1381498	316260	15.8	711.6	0143
1613	1381570	316034	14.6	712.8	0179
1620	1381639	315813	14.3	713.1	0215
1623	1381655	315582	16.6	710.8	0251
1630	1381647	315350	16.4	711.0	0287
1633	1381654	315113	12.1	715.3	0323
1640	1381687	314874	12.4	715.0	0359
1643	1381711	314634	13.8	713.6	0395
1650	1381710	314395	18.7	708.7	0431
1653	1381683	314156	16.1	711.3	0467
1660	1381626	313923	14.1	713.3	0503
1663	1381573	313690	13.7	713.7	0539
1670	1381534	313465	14.5	712.9	0575
1673	1381511	313226	15.3	712.1	0611
1680	1381463	312993	15.8	711.6	0647
1683	1381394	312770	14.8	712.6	0683
1690	1381308	312556	13.3	714.1	0720
1693	1381215	312352	11.9	715.5	0756

**WES Survey Line #1 (centerline) cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Upstream

Survey Date/Time : 23 October 1994, 1027 to 1428 hours

Water Level Elevation : 727.4 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
1700	1381142	312143	12.2	715.2	0792
1703	1381090	311926	12.5	714.9	0828
1710	1381023	311716	13.8	713.6	0864
1713	1380920	311524	13.9	713.5	0900
1720	1380793	311349	13.6	713.8	0936
1723	1380673	311163	14.3	713.1	0972
1730	1380555	310971	14.7	712.7	1008
1733	1380469	310760	16.0	711.4	1044
1740	1380383	310554	15.8	711.6	1080
1743	1380249	310375	16.3	711.1	1116
1750	1380098	310216	16.3	711.1	1151
1753	1379936	310056	16.1	711.3	1187
1760	1379779	309893	15.8	711.6	1223
1763	1379621	309730	16.1	711.3	1259
1770	1379464	309578	15.5	711.9	1295
1773	1379278	309456	15.9	711.5	1331
1780	1379071	309369	15.0	712.4	1367
1783	1378866	309279	13.8	713.6	1403
1790	1378678	309179	14.1	713.3	1439
1793	1378578	309091	13.9	713.5	1475
1800	1378238	309041	13.5	713.9	1511
1803	1378014	309026	12.6	714.8	1547
1810	1377791	308982	13.2	714.2	1583
1813	1377574	308931	12.4	715.0	1619
1820	1377353	308896	12.1	715.3	1655
1823	1377125	308877	12.3	715.1	1691
1830	1376897	308883	11.9	715.5	1727
1833	1376669	308908	12.1	715.3	1763
1840	1376448	308951	12.6	714.8	1799
1843	1376232	309014	13.3	714.1	1835
1850	1376014	309065	13.3	714.1	1871
1853	1375792	309082	13.1	714.3	1908
1860	1375577	309090	12.7	714.7	1944
1863	1375361	309142	12.5	714.9	1981
1870	1375158	309222	12.8	714.6	2017
1873	1374957	309285	12.1	715.3	2053
1880	1374751	309331	11.9	715.5	2089
1883	1374539	309384	11.6	715.8	2125
1890	1374342	309459	11.8	715.6	2161
1893	1374135	309512	12.5	714.9	2197

**WES Survey Line #1 (centerline) cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Upstream

Survey Date/Time : 23 October 1994, 1027 to 1428 hours

Water Level Elevation : 727.4 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
1900	1373928	309545	12.5	714.9	2233
1903	1373719	309597	12.6	714.8	2269
1910	1373522	309672	13.0	714.4	2305
1913	1373319	309729	13.4	714.0	2341
1920	1373115	309761	13.7	713.7	2377
1923	1372913	309807	14.2	713.2	2413
1930	1372716	309876	15.7	711.7	2449
1933	1372516	309942	17.2	710.2	2485
1940	1372306	309996	17.1	710.3	2521
1943	1372085	310040	16.5	710.9	2557
1950	1371868	310081	15.0	712.4	2593
1953	1371650	310123	14.8	712.6	2629
1960	1371429	310182	15.9	711.5	2665
1963	1371211	310231	14.8	712.6	2701
1970	1370988	310274	15.8	711.6	2737
1973	1370763	310310	16.5	710.9	2773
1980	1370544	310333	16.9	710.5	2808
1983	1370317	310329	15.9	711.5	2844
1990	1370090	310291	13.8	713.6	2880
1993	1369874	310238	12.0	715.4	2916
2000	1369648	310181	10.3	717.1	2952
2003	1369428	310154	10.7	716.7	2988
2010	1369208	310128	11.6	715.8	3024
2013	1368985	310084	12.0	715.4	3060
2020	1368766	310035	13.1	714.3	3096
2023	1368549	309967	13.6	713.8	3132
2030	1368340	309880	13.4	714.0	3168
2033	1368141	309762	13.0	714.4	3204
2040	1367948	309636	12.8	714.6	3240
2043	1367736	309531	12.6	714.8	3276
2050	1367531	309416	12.8	714.6	3312
2053	1367348	309265	12.7	714.7	3348
2060	1367192	309085	12.3	715.1	3384
2063	1367062	308887	10.8	716.6	3420
2070	1366942	308690	10.5	716.9	3456
2073	1366801	308511	10.7	716.7	3492
2080	1366641	308343	11.3	716.1	3528
2083	1366506	308153	12.4	715.0	3564
2090	1366411	307937	12.1	715.3	3600
2093	1366359	307709	11.2	716.2	3636

**WES Survey Line #1 (centerline) cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Upstream

Survey Date/Time : 23 October 1994, 1027 to 1428 hours

Water Level Elevation : 727.4 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
2100	1366340	307474	11.6	715.8	3672
2103	1366332	307238	8.8	718.6	3708
2110	1366332	307059	9.6	717.8	3744
2113	1366340	306959	10.7	716.7	3780
2120	1366351	306865	8.6	718.8	3816
2123	1366353	306765	8.3	719.1	3852
2130	1366350	306671	9.6	717.8	3888
2140	1366344	306572	9.8	717.6	3927
2143	1366358	306466	9.9	717.5	3965
2150	1366385	306347	10.3	717.1	4001
2153	1366390	306179	11.3	716.1	4037
2160	1366381	305989	11.4	716.0	4073
2163	1366432	305814	11.3	716.1	4109
2170	1366496	305644	11.0	716.4	4145
2173	1366601	305476	11.6	715.8	4181
2180	1366707	305293	11.3	716.1	4217
2183	1366773	305096	12.1	715.3	4253
2190	1366822	304905	13.2	714.2	4289
2193	1366858	304718	10.5	716.9	4325
2200	1366902	304537	10.6	716.8	4361
2203	1366949	304362	12.3	715.1	4397
2210	1366986	304207	12.8	714.6	4433

Appendix B

Survey Line #2

Positioning Information

WES Survey Line #2
Pool #3, Monongahela River, Pennsylvania

Survey Direction : Upstream
Survey Date/Time : 22 October 1994, 1148 to 1705 hours

Water Level Elevation : 727.8 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
0000	1366977	345437	15.9	711.9	0122
0003	1366891	345318	17.1	710.7	0153
0010	1366784	345208	17.2	710.6	0185
0013	1366679	345109	17.6	710.2	0216
0020	1366562	345031	18.3	709.5	0247
0023	1366445	344949	19.8	708.0	0278
0030	1366318	344861	20.2	707.6	0311
0033	1366194	344769	21.5	706.3	0343
0040	1366081	344673	22.0	705.8	0374
0043	1365974	344566	21.7	706.1	0406
0050	1365877	344447	21.8	706.0	0438
0053	1365776	344326	21.4	706.4	0471
0060	1365667	344211	20.5	707.3	0504
0063	1365554	344109	18.0	709.8	0536
0070	1365442	344008	18.9	708.9	0568
0073	1365337	343891	18.7	709.1	0601
0080	1365247	343771	16.8	711.0	0633
0083	1365169	343643	17.1	710.7	0665
0090	1365092	343509	15.7	712.1	0698
0093	1365005	343379	16.1	711.7	0731
0100	1364927	343242	15.6	712.2	0764
0103	1364869	343100	15.2	712.6	0797
0110	1364837	342951	14.3	713.5	0830
0113	1364802	342810	17.1	710.7	0862
0120	1364749	342669	16.9	710.9	0893
0123	1364665	342543	17.0	710.8	0926
0130	1364577	342418	18.1	709.7	0957
0133	1364508	342273	18.3	709.5	0988
0140	1364427	342118	17.2	710.6	1021
0143	1364338	341977	16.7	711.1	1052
0150	1364243	341838	15.4	712.4	1083
0153	1364134	341710	15.3	712.5	1115
0160	1364026	341586	15.2	712.6	1147
0163	1363898	341489	14.8	713.0	1179
0170	1363770	341396	14.9	712.9	1210
0173	1363646	341301	13.5	714.3	1242
0180	1363522	341194	13.1	714.7	1275
0190	1363332	340989	14.2	713.6	1330
0193	1363220	340865	14.7	713.1	1363
0200	1363094	340769	14.6	713.2	1394
0203	1362954	340688	14.2	713.6	1426

**WES Survey Line #2 cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Upstream

Survey Date/Time : 22 October 1994, 1148 to 1705 hours

Water Level Elevation : 727.8 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
0210	1362815	340587	14.8	713.0	1458
0213	1362687	340489	14.7	713.1	1490
0220	1362561	340385	16.0	711.8	1522
0223	1362433	340275	15.6	712.2	1555
0230	1362309	340171	16.4	711.4	1587
0233	1362180	340070	16.0	711.8	1619
0240	1362032	339993	15.6	712.2	1652
0243	1361887	339934	14.4	713.4	1683
0250	1361739	339867	13.8	714.0	1715
0253	1361594	339792	13.6	714.2	1747
0260	1361466	339703	14.2	713.6	1778
0263	1361349	339600	14.8	713.0	1809
0270	1361222	339493	14.7	713.1	1841
0273	1361080	339415	13.9	713.9	1874
0280	1360961	339355	13.4	714.4	1907
0283	1360830	339311	13.0	714.8	1940
0290	1360690	339245	12.8	715.0	1972
0293	1360543	339164	13.1	714.7	2004
0300	1360405	339090	13.3	714.5	2035
0303	1360260	339008	13.8	714.0	2068
0310	1360108	338945	13.8	714.0	2101
0313	1359958	338910	13.9	713.9	2134
0320	1359795	338881	13.9	713.9	2167
0323	1359637	338856	13.7	714.1	2199
0330	1359467	338814	13.3	714.5	2232
0333	1359311	338776	14.1	713.7	2265
0340	1359157	338748	14.2	713.6	2297
0343	1358994	338720	13.7	714.1	2330
0350	1358836	338695	13.9	713.9	2362
0353	1358664	338654	14.1	713.7	2395
0360	1358508	338629	13.8	714.0	2427
0363	1358354	338604	14.1	713.7	2460
0370	1358200	338587	13.7	714.1	2493
0373	1358036	338569	14.1	713.7	2525
0380	1357882	338546	14.5	713.3	2557
0383	1357734	338518	15.0	712.8	2589
0390	1357584	338485	15.6	712.2	2621
0393	1357424	338460	15.5	712.3	2654
0400	1357262	338450	15.7	712.1	2686
0403	1357110	338434	16.3	711.5	2716

**WES Survey Line #2 cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Upstream
Survey Date/Time : 22 October 1994, 1148 to 1705 hours

Water Level Elevation : 727.8 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
0410	1356954	338405	16.9	710.9	2748
0413	1356794	338382	16.6	711.2	2781
0420	1356634	338374	16.2	711.6	2813
0423	1356470	338377	16.9	710.9	2846
0430	1356317	338397	17.4	710.4	2877
0433	1356157	338405	18.2	709.6	2909
0440	1355993	338418	17.5	710.3	2942
0443	1355834	338427	18.3	709.5	2974
0450	1355674	338438	18.2	709.6	3006
0453	1355510	338441	17.7	710.1	3039
0460	1355350	338427	17.0	710.8	3071
0463	1355194	338394	20.0	707.8	3103
0470	1355027	338369	18.9	708.9	3136
0473	1354867	338346	19.1	708.7	3168
0480	1354708	338330	18.7	709.1	3200
0483	1354547	338334	18.6	709.2	3232
0490	1354385	338356	18.6	709.2	3264
0500	1354067	338398	19.3	708.5	3328
0503	1353915	338387	17.9	709.9	3359
0510	1353764	338374	17.6	710.2	3389
0513	1353620	338352	17.2	710.6	3419
0520	1353475	338344	18.0	709.8	3449
0523	1353328	338345	18.4	709.4	3479
0530	1353184	338351	18.7	709.1	3509
0533	1353035	338368	20.7	707.1	3539
0540	1352886	338385	21.2	706.6	3569
0543	1352737	338383	21.0	706.8	3599
0550	1352592	338358	19.6	708.2	3629
0553	1352452	338311	20.0	707.8	3659
0560	1352318	338251	22.3	705.5	3689
0563	1352184	338183	23.8	704.0	3719
0570	1352049	338123	23.9	703.9	3749
0573	1351901	338094	25.5	702.3	3779
0580	1351750	338086	22.6	705.2	3809
0583	1351598	338076	17.4	710.4	3839
0590	1351448	338064	17.6	710.2	3869
0593	1351300	338018	15.7	712.1	3899
0600	1351164	337952	15.8	712.0	3929
0603	1351035	337874	20.4	707.4	3959
0610	1350907	337793	19.8	708.0	3989
0613	1350779	337716	19.9	707.9	4019

**WES Survey Line #2 cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Upstream

Survey Date/Time : 22 October 1994, 1148 to 1705 hours

Water Level Elevation : 727.8 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
0620	1350642	337656	19.3	708.5	4049
0623	1350502	337604	18.9	708.9	4079
0630	1350364	337542	22.4	705.4	4109
0640	1350182	337423	21.5	706.3	4152
0643	1350058	337312	21.2	706.6	4185
0650	1349934	337205	21.1	706.7	4217
0653	1349803	337100	21.7	706.1	4250
0660	1349679	336988	21.2	706.6	4283
0663	1349556	336874	21.3	706.5	4315
0670	1349445	336742	22.5	705.3	4348
0673	1349354	336614	22.2	705.6	4379
0680	1349270	336482	21.6	706.2	4410
0683	1349198	336344	21.0	706.8	4441
0690	1349114	336210	20.8	707.0	4473
0693	1349004	336083	21.1	706.7	4506
0700	1348882	335961	20.9	706.9	4539
0703	1348782	335830	20.7	707.1	4571
0710	1348690	335696	20.4	707.4	4603
0713	1348611	335547	18.9	708.9	4636
0720	1348552	335400	18.9	708.9	4668
0723	1348502	335252	20.5	707.3	4700
0730	1348451	335095	20.9	706.9	4733
0733	1348427	334924	19.6	708.2	4766
0740	1348419	334759	19.9	707.9	4799
0743	1348391	334600	19.3	708.5	4831
0750	1348353	334443	19.8	708.0	4864
0753	1348307	334285	19.6	708.2	4897
0760	1348273	334126	20.3	707.5	4930
0763	1348280	333962	19.7	708.1	4963
0770	1348316	333804	19.7	708.1	4995
0773	1348338	333642	20.0	707.8	5028
0780	1348346	333482	18.9	708.9	5060
0783	1348353	333318	18.7	709.1	5093
0790	1348379	333160	17.9	709.9	5125
0793	1348441	333018	17.6	710.2	5157
0800	1348529	332877	18.0	709.8	5190
0803	1348598	332731	18.4	709.4	5222
0810	1348669	332584	19.1	708.7	5254
0813	1348766	332454	20.1	707.7	5286
0820	1348865	332321	19.5	708.3	5319
0823	1348959	332184	18.5	709.3	5352

**WES Survey Line #2 cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Upstream

Survey Date/Time : 22 October 1994, 1148 to 1705 hours

Water Level Elevation : 727.8 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
0830	1349052	332048	17.8	710.0	5384
0833	1349159	331917	16.8	711.0	5417
0840	1349263	331787	16.2	711.6	5449
0843	1349357	331655	16.5	711.3	5481
0850	1349456	331525	16.5	711.3	5514
0853	1349562	331401	16.2	711.6	5546
0860	1349666	331286	15.4	712.4	5577
0863	1349771	331164	15.7	712.1	5609
0870	1349883	331048	15.8	712.0	5642
0873	1349989	330925	15.7	712.1	5675
0880	1350075	330793	14.9	712.9	5707
0883	1350155	330651	14.7	713.1	5740
0890	1350245	330518	15.1	712.7	5772
0893	1350344	330385	15.5	712.3	5805
0900	1350452	330256	15.2	712.6	5838
0903	1350557	330131	14.9	712.9	5871
0910	1350663	330010	14.4	713.4	5903
0913	1350764	329887	13.7	714.1	5936
0920	1350859	329755	12.9	714.9	5969
0923	1350954	329626	12.2	715.6	6002
0930	1351045	329506	12.4	715.4	6033
0933	1351137	329380	11.5	716.3	6065
0940	1351239	329255	13.5	714.3	6098
0943	1351353	329142	13.3	714.5	6131
0950	1351474	329043	13.7	714.1	6163
0953	1351602	328948	14.0	713.8	6195
0960	1351728	328860	14.6	713.2	6226
0963	1351855	328764	14.6	713.2	6258
0970	1351961	328644	14.9	712.9	6290
0973	1352054	328523	14.2	713.6	6321
0980	1352153	328409	13.9	713.9	6352
0983	1352268	328303	13.8	714.0	6384
0990	1352391	328215	15.0	712.8	6415
0993	1352526	328148	14.0	713.8	6446
1000	1352665	328096	13.9	713.9	6476
1003	1352822	328054	13.9	713.9	6509
1010	1352974	328013	13.7	714.1	6541
1013	1353120	327950	13.6	714.2	6573
1020	1353246	327867	13.5	714.3	6604
1023	1353382	327789	12.9	714.9	6636

**WES Survey Line #2 cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Upstream

Survey Date/Time : 22 October 1994, 1148 to 1705 hours

Water Level Elevation : 727.8 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
1030	1353532	327728	13.0	714.8	6669
1033	1353687	327696	12.6	715.2	6701
1040	1353844	327666	12.9	714.9	6734
1043	1353996	327622	12.7	715.1	6766
1050	1354146	327570	13.1	714.7	6798
1053	1354294	327514	13.2	714.6	6830
1060	1354438	327475	13.3	714.5	6861
1063	1354591	327451	13.4	714.4	6893
1070	1354746	327435	14.0	713.8	6925
1073	1354901	327413	14.2	713.6	6957
1080	1355054	327375	14.3	713.5	6989
1083	1355199	327313	14.3	713.5	7022
1090	1355340	327244	14.5	713.3	7054
1093	1355486	327186	14.7	713.1	7087
1100	1355632	327138	14.7	713.1	7118
1103	1355780	327091	15.1	712.7	7150
1110	1355928	327053	15.5	712.3	7182
1113	1356081	327020	16.1	711.7	7215
1120	1356238	326991	15.4	712.4	7248
1123	1356391	326969	15.8	712.0	7281
1130	1356537	326940	15.1	712.7	7312
1133	1356672	326885	15.0	712.8	7343
1140	1356805	326821	14.3	713.5	7374
1143	1356944	326756	14.4	713.4	7406
1150	1357089	326685	14.1	713.7	7439
1153	1357224	326624	14.0	713.8	7470
1160	1357373	326616	15.3	712.5	7501
1163	1357529	326622	14.9	712.9	7533
1170	1357666	326576	14.8	713.0	7564
1173	1357804	326517	14.7	713.1	7595
1180	1357958	326477	13.7	714.1	7628
1183	1358115	326445	13.3	714.5	7661
1190	1358254	326396	13.3	714.5	7691
1193	1358398	326338	12.9	714.9	7723
1200	1358552	326283	12.8	715.0	7756
1203	1358698	326233	13.2	714.6	7788
1210	1358844	326184	13.2	714.6	7820
1213	1358994	326129	13.0	714.8	7853
1220	1359144	326069	13.3	714.5	7886
1223	1359290	326013	13.5	714.3	7919
1230	1359431	325959	13.8	714.0	7951
1233	1359570	325905	14.0	713.8	7983

**WES Survey Line #2 cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Upstream

Survey Date/Time : 22 October 1994, 1148 to 1705 hours

Water Level Elevation : 727.8 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
1240	1359703	325837	14.0	713.8	8015
1243	1359829	325755	13.6	714.2	8047
1250	1359955	325678	13.6	714.2	8079
1253	1360092	325608	13.5	714.3	8110
1260	1360233	325546	13.7	714.1	8142
1263	1360381	325488	14.0	713.8	8175
1270	1360529	325440	14.0	713.8	8207
1273	1360670	325367	13.6	714.2	8240
1280	1360784	325267	12.9	714.9	8271
1283	1360893	325170	12.5	715.3	8301
1290	1361008	325084	12.6	715.2	8332
1293	1361127	324995	12.5	715.3	8363
1300	1361253	324908	13.0	714.8	8395
1303	1361383	324819	12.9	714.9	8428
1310	1361494	324723	12.9	714.9	8459
1313	1361582	324604	13.1	714.7	8491
1320	1361662	324477	13.1	714.7	8523
1323	1361740	324344	12.7	715.1	8556
1330	1361831	324225	12.8	715.0	8588
1333	1361928	324107	13.0	714.8	8620
1340	1362026	323990	12.1	715.7	8652
1343	1362119	323878	12.6	715.2	8683
1350	1362238	323777	12.7	715.1	8715
1353	1362357	323678	12.9	714.9	8747
1360	1362461	323568	13.3	714.5	8779
1363	1362558	323447	13.3	714.5	8811
1370	1362655	323332	13.1	714.7	8842
1373	1362762	323226	13.4	714.4	8873
1380	1362876	323121	13.2	714.6	8906
1383	1363002	323033	12.2	715.6	8938
1400	1363985	322342	13.3	714.5	9191
1403	1364152	322269	12.8	715.0	9228
1410	1364303	322189	13.1	714.7	9264
1413	1364448	322095	13.1	714.7	9300
1420	1364595	321999	12.8	715.0	9336
1423	1364755	321927	13.3	714.5	9372
1430	1364918	321861	13.3	714.5	9408
1433	1365080	321798	13.5	714.3	9444
1440	1365245	321737	13.3	714.5	9480
1443	1365412	321680	13.7	714.1	9516
1450	1365579	321633	13.8	714.0	9552
1453	1365749	321591	13.8	714.0	9588

**WES Survey Line #2 cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Upstream

Survey Date/Time : 22 October 1994, 1148 to 1705 hours

Water Level Elevation : 727.8 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
1460	1365918	321560	13.5	714.3	9624
1463	1366093	321532	13.5	714.3	9660
1470	1366265	321512	13.2	714.6	9696
1473	1366433	321482	12.7	715.1	9732
1480	1366598	321433	13.0	714.8	9768
1483	1366758	321377	13.0	714.8	9804
1490	1366914	321311	14.1	713.7	9840
1493	1367066	321242	14.2	713.6	9876
1500	1367234	321193	14.3	713.5	9912
1503	1367403	321146	14.5	713.3	9948
1510	1367569	321124	14.2	713.6	9984
1513	1367732	321103	14.5	713.3	0020
1520	1367882	321034	15.4	712.4	0056
1523	1368040	320972	16.3	711.5	0092
1530	1368208	320926	17.1	710.7	0128
1533	1368380	320910	17.8	710.0	0164
1540	1368551	320921	19.9	707.9	0200
1543	1368717	320919	18.9	708.9	0236
1550	1368887	320896	17.8	710.0	0272
1553	1369055	320861	17.7	710.1	0308
1560	1369224	320826	18.0	709.8	0344
1563	1369399	320825	17.5	710.3	0380
1570	1369570	320836	18.6	709.2	0416
1573	1369738	320839	19.8	708.0	0452
1580	1369913	320844	19.9	707.9	0488
1583	1370086	320856	19.6	708.2	0524
1590	1370255	320874	19.3	708.5	0560
1593	1370426	320875	18.0	709.8	0596
1600	1370592	320866	16.9	710.9	0632
1603	1370759	320898	15.9	711.9	0668
1610	1370920	320942	14.7	713.1	0704
1613	1371085	320976	13.9	713.9	0740
1620	1371252	321004	12.4	715.4	0776
1623	1371419	321035	12.1	715.7	0812
1630	1371586	321075	12.0	715.8	0848
1633	1371748	321134	12.9	714.9	0884
1640	1371909	321184	13.5	714.3	0920
1643	1372072	321231	13.9	713.9	0956
1650	1372237	321275	14.7	713.1	0992
1653	1372406	321315	13.5	714.3	1028
1660	1372576	321357	13.9	713.9	1064
1663	1372747	321397	13.9	713.9	1100

**WES Survey Line #2 cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Upstream
Survey Date/Time : 22 October 1994, 1148 to 1705 hours

Water Level Elevation : 727.8 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
1670	1372915	321449	12.5	715.3	1136
1673	1373078	321510	13.1	714.7	1172
1680	1373240	321573	12.5	715.3	1208
1683	1373405	321618	12.5	715.3	1244
1690	1373574	321641	12.7	715.1	1280
1693	1373745	321644	12.2	715.6	1316
1700	1373916	321654	11.8	716.0	1352
1703	1374082	321669	12.4	715.4	1388
1710	1374253	321699	11.9	715.9	1424
1713	1374420	321722	11.8	716.0	1460
1720	1374582	321720	10.3	717.5	1496
1723	1374748	321702	9.8	718.0	1532
1730	1374921	321702	10.2	717.6	1568
2000	1375263	321747	10.8	717.0	1641
2003	1375432	321783	11.8	716.0	1678
2010	1375601	321794	12.8	715.0	1714
2013	1375767	321787	11.8	716.0	1750
2020	1375933	321790	11.7	716.1	1786
2023	1376104	321799	12.3	715.5	1822
2030	1376275	321810	12.5	715.3	1858
2033	1376443	321800	12.7	715.1	1894
2040	1376611	321777	12.9	714.9	1930
2043	1376781	321748	13.1	714.7	1966
2050	1376953	321719	14.0	713.8	2002
2053	1377127	321687	13.6	714.2	2038
2060	1377296	321641	13.3	714.5	2074
2063	1377470	321605	13.7	714.1	2110
2070	1377642	321569	13.9	713.9	2146
2073	1377812	321530	15.3	712.5	2182
2080	1377968	321465	15.9	711.9	2218
2083	1378111	321371	14.9	712.9	2254
2090	1378258	321279	14.4	713.4	2290
2093	1378407	321194	14.3	713.5	2326
2100	1378565	321120	15.4	712.4	2362
2103	1378719	321047	15.9	711.9	2398
2110	1378873	320969	16.7	711.1	2434
2113	1379018	320871	17.6	710.2	2470
2120	1379154	320765	18.0	709.8	2506
2123	1379283	320654	18.5	709.3	2542
2130	1379402	320530	17.1	710.7	2578
2133	1379524	320407	14.8	713.0	2614

**WES Survey Line #2 cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Upstream

Survey Date/Time : 22 October 1994, 1148 to 1705 hours

Water Level Elevation : 727.8 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
2140	1379658	320298	14.1	713.7	2650
2143	1379816	320207	16.7	711.1	2687
2150	1379968	320123	18.6	709.2	2723
2153	1380101	320014	18.9	708.9	2759
2160	1380213	319884	18.1	709.7	2795
2163	1380310	319739	16.5	711.3	2831
2170	1380392	319587	15.1	712.7	2867
2173	1380476	319432	15.0	712.8	2903
2180	1380574	319286	14.4	713.4	2939
2183	1380678	319143	14.8	713.0	2975
2190	1380761	318991	15.3	712.5	3011
2193	1380826	318831	14.4	713.4	3047
2200	1380873	318667	14.8	713.0	3083
2203	1380912	318498	13.6	714.2	3119
2210	1380961	318334	13.6	714.2	3155
2213	1381013	318169	12.2	715.6	3191
2220	1381062	318002	12.7	715.1	3227
2223	1381111	317835	13.1	714.7	3263
2230	1381146	317668	12.9	714.9	3299
2233	1381159	317495	12.8	715.0	3335
2240	1381176	317324	12.7	715.1	3371
2243	1381208	317152	13.9	713.9	3407
2250	1381276	317049	14.0	713.8	3442
2253	1381296	316825	13.4	714.4	3478
2260	1381324	316667	13.2	714.6	3512
2263	1381344	316497	13.1	714.7	3548
2270	1381380	316336	13.4	714.4	3582
2273	1381428	316170	13.7	714.1	3618
2280	1381468	316002	14.6	713.2	3654
2283	1381499	315838	15.5	712.3	3689
2290	1381510	315681	15.4	712.4	3723
2293	1381523	315513	15.1	712.7	3758
2300	1381545	315348	14.5	713.3	3793
2303	1381575	315189	12.6	715.2	3827
2310	1381614	315027	12.8	715.0	3862
2313	1381638	314866	13.3	714.5	3897
2320	1381615	314707	13.7	714.1	3932
2323	1381572	314541	13.3	714.5	3968
2330	1381547	314368	12.2	715.6	4004
2333	1381543	314193	11.3	716.5	4040
2340	1381539	314024	11.4	716.4	4075
2343	1381526	313851	12.7	715.1	4111

**WES Survey Line #2 cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Upstream

Survey Date/Time : 22 October 1994, 1148 to 1705 hours

Water Level Elevation : 727.8 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
2350	1381507	313680	14.0	713.8	4147
2353	1381480	313512	12.7	715.1	4182
2360	1381448	313346	12.8	715.0	4217
2363	1381406	313179	12.8	715.0	4253
2370	1381359	313023	12.4	715.4	4287
2373	1381306	312861	11.7	716.1	4323
2380	1381253	312700	11.1	716.7	4359
2383	1381196	312546	11.2	716.6	4394
2390	1381137	312384	11.0	716.8	4430
2393	1381084	312225	10.7	717.1	4465
2400	1381025	312074	11.2	716.6	4499
2403	1380953	311922	11.1	716.7	4534
2410	1380871	311782	10.6	717.2	4568
2413	1380784	311637	10.7	717.1	4603
2420	1380700	311484	11.1	716.7	4639
2423	1380626	311331	12.4	715.4	4674
2430	1380558	311181	11.0	716.8	4708
2433	1380491	311027	11.6	716.2	4743
2440	1380412	310882	11.8	716.0	4778
2443	1380317	310742	12.5	715.3	4814
2450	1380212	310616	11.9	715.9	4849
2453	1380096	310499	11.8	716.0	4884
2460	1379989	310374	11.8	716.0	4919
2463	1379885	310240	12.5	715.3	4955
2470	1379782	310112	12.9	714.9	4990
2473	1379664	309991	13.0	714.8	5026
2480	1379548	309879	12.8	715.0	5060
2483	1379422	309769	13.2	714.6	5096
2490	1379289	309664	13.1	714.7	5132
2493	1379148	309568	12.7	715.1	5168
2500	1379005	309476	12.5	715.3	5204
2503	1378862	309390	12.2	715.6	5239
2510	1378720	309308	12.4	715.4	5274
2513	1378577	309230	12.6	715.2	5309
2520	1378480	309173	12.8	715.0	5344
2523	1378272	309136	12.4	715.4	5379
2530	1378103	309119	12.4	715.4	5415
2533	1377934	309114	11.4	716.4	5451
2540	1377772	309108	11.1	716.7	5485
2543	1377601	309095	11.1	716.7	5520
2550	1377430	309070	11.2	716.6	5556
2553	1377270	309044	11.3	716.5	5590

**WES Survey Line #2 cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Upstream

Survey Date/Time : 22 October 1994, 1148 to 1705 hours

Water Level Elevation : 727.8 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
2560	1377103	309024	11.1	716.7	5626
2563	1376951	309030	11.3	716.5	5660
2570	1376787	309041	11.1	716.7	5696
2573	1376632	309055	11.5	716.3	5731
2580	1376479	309085	11.6	716.2	5766
2583	1376324	309125	12.3	715.5	5802
2590	1376174	309162	12.6	715.2	5836
2593	1376021	309196	12.8	715.0	5871
2600	1375868	309227	13.2	714.6	5907
2603	1375715	309257	12.7	715.1	5943
2610	1375563	309297	12.3	715.5	5979
2613	1375412	309331	12.8	715.0	6014
2620	1375268	309358	12.5	715.3	6048
2623	1375119	309388	12.4	715.4	6083
2630	1374969	309423	12.4	715.4	6118
2633	1374814	309454	12.0	715.8	6153
2640	1374657	309490	12.0	715.8	6188
2643	1374498	309527	11.3	716.5	6223
2650	1374345	309566	12.0	715.8	6257
2653	1374188	309610	13.3	714.5	6292
2660	1374032	309662	12.2	715.6	6327
2663	1373875	309712	13.0	714.8	6362
2670	1373729	309764	14.4	713.4	6395
2673	1373577	309809	14.5	713.3	6428
2680	1373424	309842	16.4	711.4	6461
2683	1373260	309861	15.5	712.3	6495
2690	1373087	309864	15.6	712.2	6531
2693	1372930	309878	15.3	712.5	6565
2700	1372771	309912	16.3	711.5	6600
2703	1372625	309984	16.4	711.4	6635
2710	1372478	310062	15.5	712.3	6670
2713	1372319	310108	16.5	711.3	6705
2720	1372156	310141	16.7	711.1	6740
2723	1371999	310178	17.3	710.5	6775
2730	1371852	310221	16.1	711.7	6808
2733	1371696	310259	15.5	712.3	6843
2740	1371543	310296	15.1	712.7	6877
2743	1371384	310328	15.4	712.4	6912
2750	1371224	310353	13.8	714.0	6947
2753	1371064	310361	15.5	712.3	6982
2760	1370915	310360	16.7	711.1	7015
2763	1370760	310361	17.2	710.6	7049

**WES Survey Line #2 cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Upstream
Survey Date/Time : 22 October 1994, 1148 to 1705 hours

Water Level Elevation : 727.8 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
2770	1370602	310370	17.5	710.3	7084
2773	1370444	310385	16.5	711.3	7118
2780	1370285	310398	17.5	710.3	7152
2783	1370125	310399	17.1	710.7	7186
2790	1369965	310396	16.9	710.9	7220
2793	1369809	310390	16.7	711.1	7254
2800	1369655	310374	16.7	711.1	7287
2803	1369497	310354	16.2	711.6	7321
2810	1369338	310329	16.6	711.2	7355
2813	1369178	310298	16.2	711.6	7390
2820	1369021	310264	16.0	711.8	7424
2823	1368869	310222	15.8	712.0	7458
2830	1368714	310172	15.9	711.9	7493
2833	1368561	310106	14.9	712.9	7529
2840	1368425	310037	14.3	713.5	7562
2843	1368282	309961	13.8	714.0	7596
2850	1368138	309898	13.8	714.0	7630
2853	1367989	309839	13.6	714.2	7664
2860	1367843	309781	12.9	714.9	7698
2863	1367696	309700	12.5	715.3	7733
2870	1367570	309604	11.1	716.7	7767
2873	1367458	309493	12.1	715.7	7801
2880	1367355	309380	12.7	715.1	7834
2883	1367246	309268	12.6	715.2	7868
2890	1367140	309149	11.8	716.0	7902
2893	1367037	309028	12.6	715.2	7936
2900	1366932	308896	13.0	714.8	7972
2903	1366830	308770	13.0	714.8	8006
2910	1366727	308648	12.7	715.1	8040
2913	1366611	308523	12.7	715.1	8076
2920	1366506	308409	12.8	715.0	8109
2923	1366415	308279	13.2	714.6	8143
2930	1366352	308123	13.2	714.6	8178
2933	1366308	307969	13.5	714.3	8212
2940	1366268	307817	13.6	714.2	8245
2943	1366221	307662	13.2	714.6	8279
2950	1366181	307496	13.2	714.6	8315
2953	1366141	307337	13.4	714.4	8350
2960	1366109	307180	13.2	714.6	8384
3000	1366239	306199	13.0	714.8	8597
3003	1366261	306060	13.2	714.6	8628

**WES Survey Line #2 cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Upstream

Survey Date/Time : 22 October 1994, 1148 to 1705 hours

Water Level Elevation : 727.8 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
3010	1366292	305928	13.4	714.4	8658
3013	1366340	305799	12.9	714.9	8688
3020	1366399	305677	12.3	715.5	8718
3023	1366458	305562	12.7	715.1	8748
3030	1366543	305454	12.8	715.0	8778
3033	1366614	305342	13.1	714.7	8808
3040	1366665	305219	13.0	714.8	8839
3043	1366700	305082	13.4	714.4	8871
3050	1366741	304943	13.1	714.7	8903
3053	1366789	304811	11.3	716.5	8934
3060	1366837	304678	11.4	716.4	8966
3063	1366890	304545	10.7	717.1	8998
3070	1366959	304425	12.0	715.8	9029
3073	1367053	304322	12.9	714.9	9060
3080	1367142	304238	11.1	716.7	9092

Appendix C

Survey Line #3

Positioning Information

WES Survey Line #3
Pool #3, Monongahela River, Pennsylvania

Survey Direction : Upstream
 Survey Date/Time : 25 October 1994, 0914 to 1342 hours

Water Level Elevation : 727.4 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
0000	1367744	345802	12.0	715.4	0035
0003	1367638	345756	12.3	715.1	0068
0010	1367545	345692	12.2	715.2	0101
0013	1367471	345614	12.1	715.3	0134
0020	1367401	345531	12.7	714.7	0167
0023	1367333	345443	13.2	714.2	0200
0030	1367228	345328	13.0	714.4	0232
0033	1367097	345207	13.2	714.2	0265
0040	1366958	345102	13.8	713.6	0296
0043	1366811	345022	14.2	713.2	0326
0050	1366672	344924	15.7	711.7	0357
0053	1366552	344799	15.1	712.3	0388
0060	1366442	344659	14.4	713.0	0421
0063	1366335	344517	12.8	714.6	0453
0070	1366217	344408	17.4	710.0	0483
0073	1366076	344290	16.0	711.4	0516
0080	1365943	344172	16.0	711.4	0548
0083	1365820	344036	16.7	710.7	0581
0090	1365723	343895	14.1	713.3	0612
0093	1365630	343747	14.8	712.6	0644
0100	1365529	343614	16.5	710.9	0675
0103	1365417	343491	23.5	703.9	0707
0110	1365316	343356	23.8	703.6	0739
0113	1365198	343259	19.0	708.4	0771
0120	1365126	343081	22.0	705.4	0802
0123	1365025	342950	15.3	712.1	0834
0130	1364943	342824	16.2	711.2	0864
0133	1364867	342682	17.1	710.3	0896
0140	1364835	342514	15.3	712.1	0928
0143	1364799	342358	14.6	712.8	0959
0150	1364700	342224	14.3	713.1	0990
0153	1364561	342025	17.0	710.4	1021
0160	1364443	341811	16.9	710.5	1052
0163	1364321	341614	16.4	711.0	1082
0170	1364184	341421	18.6	708.8	1114
0173	1364029	341273	17.5	709.9	1145
0180	1363856	341137	16.0	711.4	1177
0183	1363658	341007	14.7	712.7	1210
0190	1363470	340881	14.8	712.6	1241
0193	1363294	340723	15.3	712.1	1273
0200	1363124	340570	15.2	712.2	1304
0203	1362950	340441	15.1	712.3	1334

**WES Survey Line #3 cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Upstream

Survey Date/Time : 25 October 1994, 0914 to 1342 hours

Water Level Elevation : 727.4 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
0210	1362774	340296	16.1	711.3	1365
0213	1362588	340163	15.9	711.5	1397
0220	1362401	340026	16.6	710.8	1429
0223	1362212	339901	17.5	709.9	1460
0230	1362007	339787	16.2	711.2	1492
0233	1361815	339669	14.5	712.9	1522
0240	1361627	339559	14.8	712.6	1552
0243	1361434	339428	16.2	711.2	1583
0250	1361262	339285	16.1	711.3	1613
0253	1361065	339172	15.2	712.2	1644
0260	1360852	339090	14.2	713.2	1675
0263	1360635	339013	15.2	712.2	1706
0270	1360427	338929	14.5	712.9	1736
0273	1360222	338823	15.1	712.3	1766
0280	1360012	338706	15.8	711.6	1798
0283	1359801	338614	16.1	711.3	1829
0290	1359555	338580	15.2	712.2	1862
0293	1359304	338573	14.6	712.8	1895
0300	1359064	338542	14.9	712.5	1927
0303	1358837	338486	16.1	711.3	1958
0310	1358603	338395	16.1	711.3	1991
0313	1358377	338322	15.9	711.5	2023
0320	1358146	338304	16.0	711.4	2054
0323	1357904	338301	15.8	711.6	2086
0330	1357663	338303	15.9	711.5	2118
0333	1357437	338290	16.0	711.4	2148
0340	1357204	338271	16.3	711.1	2179
0343	1356960	338244	15.7	711.7	2211
0350	1356715	338220	15.8	711.6	2243
0353	1356472	338226	15.7	711.7	2275
0360	1356236	338230	16.1	711.3	2307
0363	1356018	338235	17.0	710.4	2338
0370	1355782	338232	16.6	710.8	2370
0373	1355556	338219	17.1	710.3	2400
0380	1355328	338215	17.6	709.8	2430
0383	1355085	338223	17.2	710.2	2462
0390	1354842	338227	17.1	710.3	2494
0393	1354610	338219	17.4	710.0	2525
0400	1354392	338193	17.1	710.3	2555
0403	1354163	338160	16.4	711.0	2587
0410	1353926	338138	15.0	712.4	2620
0413	1353687	338129	15.5	711.9	2653

**WES Survey Line #3 cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Upstream
Survey Date/Time : 25 October 1994, 0914 to 1342 hours

Water Level Elevation : 727.4 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
0420	1353450	338115	14.8	712.6	2685
0423	1353212	338109	15.0	712.4	2717
0430	1352977	338106	15.0	712.4	2749
0433	1352753	338099	15.5	711.9	2780
0440	1352513	338103	16.3	711.1	2813
0443	1352269	338082	17.5	709.9	2846
0450	1352057	338031	17.5	709.9	2876
0453	1351834	337957	17.2	710.2	2908
0460	1351618	337858	15.8	711.6	2940
0463	1351403	337780	16.1	711.3	2971
0470	1351188	337708	17.4	710.0	3002
0473	1350976	337648	17.3	710.1	3032
0480	1350765	337561	17.1	710.3	3063
0483	1350557	337423	16.7	710.7	3096
0490	1350376	337269	15.0	712.4	3128
0493	1350202	337115	14.2	713.2	3159
0500	1350017	336970	14.4	713.0	3190
0503	1349822	336843	16.9	710.5	3221
0510	1349636	336714	18.9	708.5	3251
0513	1349465	336530	18.5	708.9	3284
0520	1349357	336325	15.2	712.2	3314
0523	1349252	336105	13.3	714.1	3346
0530	1349123	335905	12.6	714.8	3378
0533	1348994	335696	12.0	715.4	3411
0540	1348912	335485	11.4	716.0	3441
0543	1348834	335258	10.0	717.4	3473
0550	1348727	335057	11.5	715.9	3504
0553	1348596	334856	14.2	713.2	3537
0560	1348527	334641	14.7	712.7	3567
0563	1348498	334417	14.8	712.6	3597
0570	1348522	334183	12.9	714.5	3629
0573	1348558	333958	12.3	715.1	3660
0580	1348576	333742	13.9	713.5	3690
0583	1348582	333517	16.5	710.9	3721
0590	1348601	333288	15.9	711.5	3752
0593	1348666	333053	16.2	711.2	3784
0600	1348771	332834	16.5	710.9	3816
0603	1348911	332651	16.6	710.8	3847
0610	1349082	332471	15.4	712.0	3880
0613	1349202	332264	16.2	711.2	3912
0620	1349327	332052	15.8	711.6	3944
0623	1349473	331862	15.3	712.1	3975

**WES Survey Line #3 cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Upstream

Survey Date/Time : 25 October 1994, 0914 to 1342 hours

Water Level Elevation : 727.4 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
0630	1349638	331705	17.4	710.0	4005
0633	1349797	331527	17.0	710.4	4037
0640	1349946	331347	16.1	711.3	4068
0643	1350082	331144	15.1	712.3	4100
0650	1350219	330937	13.7	713.7	4133
0653	1350342	330728	14.0	713.4	4165
0660	1350465	330538	13.4	714.0	4195
0663	1350638	330354	12.3	715.1	4228
0670	1350810	330180	11.7	715.7	4260
0673	1350998	330011	10.3	717.1	4293
0680	1351170	329837	9.8	717.6	4325
0683	1351321	329647	10.3	717.1	4357
0690	1351459	329454	11.0	716.4	4389
0693	1351594	329251	12.1	715.3	4421
0700	1351728	329045	12.8	714.6	4453
0703	1351889	328858	13.0	714.4	4485
0710	1352083	328687	13.5	713.9	4518
0713	1352269	328527	13.8	713.6	4550
0720	1352468	328383	13.9	713.5	4582
0723	1352691	328270	13.3	714.1	4615
0730	1352923	328174	13.1	714.3	4648
0733	1353150	328114	15.3	712.1	4678
0740	1353396	328072	15.5	711.9	4710
0743	1353635	327991	13.6	713.8	4743
0750	1353863	327905	11.6	715.8	4775
0753	1354106	327846	16.8	710.6	4808
0760	1354339	327759	12.1	715.3	4840
0763	1354573	327667	14.2	713.2	4873
0770	1354810	327596	14.0	713.4	4905
0773	1355041	327538	14.1	713.3	4936
0780	1355274	327491	13.0	714.4	4967
0783	1355525	327450	13.3	714.1	4999
0790	1355770	327376	15.3	712.1	5031
0793	1355998	327279	15.3	712.1	5063
0800	1356221	327170	16.2	711.2	5095
0803	1356451	327058	16.2	711.2	5128
0810	1356688	326988	15.6	711.8	5160
0813	1356495	327052	16.2	711.2	5628
0820	1356676	327044	15.9	711.5	5662
0823	1356846	327008	16.0	711.4	5695
0830	1357002	326949	15.8	711.6	5727
0833	1357165	326906	15.5	711.9	5760

**WES Survey Line #3 cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Upstream
Survey Date/Time : 25 October 1994, 0914 to 1342 hours

Water Level Elevation : 727.4 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
0840	1357331	326882	14.8	712.6	5793
0843	1357496	326861	14.3	713.1	5825
0850	1357662	326822	14.2	713.2	5858
0853	1357814	326758	13.8	713.6	5890
0860	1357974	326703	13.1	714.3	5923
0863	1358137	326649	13.1	714.3	5956
0870	1358306	326595	12.7	714.7	5987
0873	1358509	326517	12.4	715.0	6020
0880	1358919	326364	12.3	715.1	6085
0883	1359130	326294	13.4	714.0	6118
0890	1359342	326223	13.8	713.6	6151
0893	1359548	326146	13.3	714.1	6184
0900	1359749	326067	13.2	714.2	6216
0903	1359947	325979	15.4	712.0	6248
0910	1360145	325882	15.7	711.7	6281
0913	1360341	325777	16.5	710.9	6314
0920	1360521	325663	16.2	711.2	6345
0923	1360702	325533	15.4	712.0	6378
0930	1360871	325408	14.7	712.7	6409
0933	1361036	325276	13.1	714.3	6440
0940	1361206	325141	11.9	715.5	6472
0943	1361360	324999	11.9	715.5	6503
0950	1361538	324859	11.3	716.1	6536
0953	1361709	324715	10.7	716.7	6569
0960	1361852	324564	10.4	717.0	6600
0963	1362012	324389	10.7	716.7	6633
0970	1362149	324226	10.4	717.0	6664
0973	1362283	324049	10.9	716.5	6696
0980	1362409	323883	11.3	716.1	6726
0983	1362552	323713	11.6	715.8	6758
0990	1362702	323564	11.3	716.1	6789
0993	1362860	323417	11.0	716.4	6821
1000	1363001	323248	10.9	716.5	6854
1003	1363142	323078	11.0	716.4	6887
1010	1363311	322949	11.1	716.3	6919
1013	1363492	322847	11.4	716.0	6949
1020	1363692	322756	10.8	716.6	6982
1023	1363880	322674	10.7	716.7	7012
1030	1364074	322580	10.2	717.2	7044
1033	1364259	322472	10.4	717.0	7076
1040	1364435	322357	10.7	716.7	7107
1043	1364635	322251	11.1	716.3	7140

**WES Survey Line #3 cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Upstream

Survey Date/Time : 25 October 1994, 0914 to 1342 hours

Water Level Elevation : 727.4 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
1050	1364829	322157	11.0	716.4	7172
1053	1365036	322068	10.8	716.6	7205
1060	1365241	322004	10.6	716.8	7237
1063	1365455	321946	10.2	717.2	7270
1070	1365649	321878	10.2	717.2	7301
1080	1365928	321762	10.4	717.0	7346
1083	1366148	321702	10.0	717.4	7380
1090	1366354	321648	10.5	716.9	7412
1093	1366563	321593	10.0	717.4	7444
1100	1366754	321532	10.9	716.5	7474
1103	1366963	321464	11.5	715.9	7506
1110	1367159	321387	12.8	714.6	7537
1113	1367374	321337	12.5	714.9	7569
1120	1367601	321320	12.9	714.5	7602
1123	1367812	321297	12.2	715.2	7633
1130	1368022	321248	11.9	715.5	7664
1133	1368233	321184	12.4	715.0	7696
1140	1368443	321132	13.1	714.3	7727
1143	1368659	321083	14.1	713.3	7759
1150	1368867	321037	14.2	713.2	7790
1153	1369081	320987	15.4	712.0	7822
1160	1369300	320968	16.0	711.4	7854
1163	1369527	320982	14.8	712.6	7887
1170	1369749	321014	13.7	713.7	7919
1173	1369967	321049	14.9	712.5	7950
1180	1370183	321073	16.7	710.7	7981
1183	1370416	321071	20.4	707.0	8014
1190	1370636	321091	19.5	707.9	8045
1193	1370850	321114	16.7	710.7	8076
1200	1371057	321128	14.5	712.9	8106
1203	1371273	321156	14.0	713.4	8137
1210	1371492	321212	14.2	713.2	8169
1213	1371696	321278	13.9	713.5	8199
1220	1371904	321355	12.4	715.0	8230
1223	1372114	321411	13.0	714.4	8261
1230	1372331	321450	14.0	713.4	8292
1233	1372539	321501	14.4	713.0	8323
1240	1372738	321561	13.4	714.0	8353
1243	1372932	321647	14.1	713.3	8384
1250	1373112	321741	13.3	714.1	8414
1253	1373309	321806	13.1	714.3	8445
1260	1373530	321837	12.6	714.8	8477
1263	1373743	321856	11.9	715.5	8508

WES Survey Line #3 cont.
Pool #3, Monongahela River, Pennsylvania

Survey Direction : Upstream

Survey Date/Time : 25 October 1994, 0914 to 1342 hours

Water Level Elevation : 727.4 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
1270	1373972	321900	12.4	715.0	8540
1273	1374186	321931	12.4	715.0	8571
1280	1374389	321919	13.6	713.8	8601
1283	1374617	321919	13.6	713.8	8634
1290	1374822	321944	13.6	713.8	8664
1293	1375051	321966	13.6	713.8	8697
1300	1375268	321973	13.9	713.5	8728
1303	1375484	321975	13.2	714.2	8759
1310	1376429	321938	13.0	714.4	8895
1313	1376675	321960	12.2	715.2	8930
1320	1376925	321976	12.4	715.0	8966
1323	1377172	321964	12.7	714.7	9002
1330	1377409	321891	13.8	713.6	9038
1333	1377637	321790	13.8	713.6	9074
1340	1377871	321708	15.0	712.4	9110
1343	1378093	321600	16.7	710.7	9146
1350	1378307	321475	16.9	710.5	9182
1353	1378533	321371	17.6	709.8	9218
1360	1378756	321268	14.4	713.0	9254
1363	1378962	321138	16.3	711.1	9290
1370	1379163	320990	14.4	713.0	9326
1373	1379310	320799	16.6	710.8	9362
1380	1379439	320593	20.2	707.2	9398
1383	1379603	320408	15.8	711.6	9434
1390	1379770	320229	14.5	712.9	9470
1393	1379949	320052	13.3	714.1	9506
1400	1380143	319882	14.5	712.9	9542
1403	1380351	319766	17.2	710.2	9578
1410	1380577	319657	15.9	711.5	9614
1413	1380773	319487	13.8	713.6	9650
1420	1380902	319249	15.1	712.3	9686
1423	1381002	318999	15.0	712.4	9722
1430	1381078	318761	15.3	712.1	9758
1433	1381117	318521	14.9	712.5	9794
1440	1381158	318282	13.5	713.9	9830
1443	1381208	318047	12.1	715.3	9866
1450	1381254	317818	11.7	715.7	9902
1453	1381304	317586	11.5	715.9	9938
1460	1381328	317345	12.4	715.0	9974
1463	1381356	317119	13.5	713.9	0010
1470	1381437	316905	12.0	715.4	0046
1473	1381530	316691	13.4	714.0	0082

**WES Survey Line #3 cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Upstream

Survey Date/Time : 25 October 1994, 0914 to 1342 hours

Water Level Elevation : 727.4 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
1480	1381616	316475	13.1	714.3	0118
1483	1381647	316241	13.6	713.8	0154
1490	1381656	316004	14.2	713.2	0190
1493	1381663	315769	14.4	713.0	0226
1500	1381677	315530	17.0	710.4	0262
1503	1381692	315289	16.1	711.3	0298
1510	1381730	315050	10.3	717.1	0334
1513	1381771	314817	10.9	716.5	0370
1520	1381795	314576	13.7	713.7	0406
1523	1381811	314338	11.0	716.4	0442
1530	1381812	314112	18.4	709.0	0478
1533	1381757	313889	14.4	713.0	0514
1540	1381705	313668	15.6	711.8	0550
1543	1381664	313442	16.4	711.0	0586
1550	1381656	313208	16.4	711.0	0622
1553	1381618	312978	17.7	709.7	0658
1560	1381551	312751	17.4	710.0	0694
1563	1381456	312538	16.5	710.9	0730
1570	1381385	312310	16.0	711.4	0766
1573	1381316	312087	14.3	713.1	0802
1580	1381230	311874	13.4	714.0	0838
1583	1381120	311669	13.8	713.6	0874
1590	1381021	311460	14.4	713.0	0910
1593	1380931	311254	14.3	713.1	0946
1600	1380796	311067	14.6	712.8	0982
1603	1380685	310852	15.4	712.0	1019
1610	1380567	310651	15.4	712.0	1055
1613	1380432	310465	13.8	713.6	1091
1620	1380283	310291	15.1	712.3	1127
1623	1380117	310122	12.3	715.1	1163
1630	1379945	309962	15.0	712.4	1199
1633	1379777	309801	14.4	713.0	1235
1640	1379600	309641	15.6	711.8	1271
1643	1379415	309498	14.6	712.8	1307
1650	1379237	309352	14.6	712.8	1343
1653	1379040	309240	14.1	713.3	1379
1660	1378835	309142	14.2	713.2	1415
1663	1378626	309049	13.4	714.0	1451
1670	1378392	308982	12.8	714.6	1487
1673	1378171	308934	12.8	714.6	1523
1680	1377944	308876	13.4	714.0	1559
1683	1377708	308837	13.1	714.3	1596

**WES Survey Line #3 cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Upstream

Survey Date/Time : 25 October 1994, 0914 to 1342 hours

Water Level Elevation : 727.4 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
1690	1377478	308834	12.5	714.9	1632
1693	1377254	308820	11.9	715.5	1668
1700	1377025	308809	11.8	715.6	1704
1703	1376799	308820	12.0	715.4	1740
1710	1376563	308834	11.3	716.1	1776
1713	1376335	308862	11.9	715.5	1812
1720	1376106	308906	12.0	715.4	1848
1723	1375882	308978	12.4	715.0	1884
1730	1375659	309027	12.4	715.0	1920
1733	1375432	309074	12.4	715.0	1956
1740	1375215	309123	11.7	715.7	1992
1743	1375001	309173	10.4	717.0	2028
1750	1374787	309231	11.0	716.4	2064
1753	1374577	309282	10.6	716.8	2100
1760	1374367	309334	10.6	716.8	2136
1763	1374157	309394	11.2	716.2	2172
1770	1373948	309471	11.7	715.7	2208
1773	1373737	309551	11.9	715.5	2244
1780	1373525	309621	12.7	714.7	2280
1783	1373320	309699	12.8	714.6	2316
1790	1373098	309760	13.5	713.9	2352
1793	1372880	309833	14.1	713.3	2388
1800	1372659	309895	15.4	712.0	2424
1803	1372435	309965	16.5	710.9	2460
1810	1372231	309907	14.2	713.2	2496
1813	1372006	309950	12.6	714.8	2532
1820	1371780	309980	13.0	714.4	2568
1823	1371558	310025	10.5	716.9	2604
1830	1371351	310106	11.8	715.6	2640
1833	1371137	310178	13.6	713.8	2676
1840	1370918	310220	14.1	713.3	2712
1843	1370698	310218	12.9	714.5	2748
1850	1370474	310204	11.8	715.6	2784
1853	1370250	310177	11.0	716.4	2820
1860	1370026	310169	10.8	716.6	2856
1863	1369801	310162	10.4	717.0	2892
1870	1369581	310141	10.2	717.2	2928
1873	1369360	310100	9.8	717.6	2964
1880	1369148	310060	10.6	716.8	3000
1883	1368938	310002	9.1	718.3	3036
1890	1368721	309932	9.5	717.9	3072
1893	1368510	309851	9.9	717.5	3108

**WES Survey Line #3 cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Upstream

Survey Date/Time : 25 October 1994, 0914 to 1342 hours

Water Level Elevation : 727.4 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
1900	1368307	309759	10.2	717.2	3144
1903	1368106	309664	11.3	716.1	3180
1910	1367914	309550	10.7	716.7	3216
1913	1367740	309408	10.5	716.9	3252
1920	1367589	309251	10.2	717.2	3288
1923	1367406	309115	11.7	715.7	3324
1930	1367213	308992	9.9	717.5	3360
1933	1367037	308857	11.0	716.4	3395
1940	1366886	308690	11.1	716.3	3431
1943	1366789	308482	10.7	716.7	3467
1950	1366718	308270	9.8	717.6	3503
1953	1366615	308078	9.4	718.0	3539
1960	1366533	307876	9.5	717.9	3575
1963	1366451	307661	8.8	718.6	3611
1970	1366380	307433	10.8	716.6	3647
1973	1366370	307189	7.0	720.4	3683
1980	1366379	306955	5.5	721.9	3719
1983	1366358	306722	9.5	717.9	3755
1990	1366342	306483	10.3	717.1	3791
1993	1366389	306243	10.7	716.7	3827
2000	1366469	306013	10.5	716.9	3863
2003	1366538	305789	10.3	717.1	3899
2010	1366567	305592	10.2	717.2	3935
2013	1366662	305367	10.9	716.5	3971
2020	1366746	305151	11.9	715.5	4007
2023	1366790	304925	13.4	714.0	4043
2030	1366825	304694	10.4	717.0	4079
2033	1366858	304476	8.9	718.5	4115

Appendix D

Survey Lines #4a and #4b

Positioning Information

WES Survey Line #4a
Pool #3, Monongahela River, Pennsylvania

Survey Direction : Downstream

Survey Date/Time : 23 October 1994, 1518 to 1731 hours

Water Level Elevation : 727.4 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
0000	1380397	311020	8.3	719.1	0118
0003	1380490	311204	8.6	718.8	0151
0010	1380630	311400	9.3	718.1	0183
0013	1380737	311625	9.1	718.3	0216
0020	1380845	311849	9.3	718.1	0249
0023	1380940	312075	9.1	718.3	0282
0030	1381014	312311	9.8	717.6	0315
0033	1381094	312545	8.4	719.0	0348
0040	1381202	312778	9.4	718.0	0381
0043	1381297	313012	10.4	717.0	0414
0050	1381339	313255	9.5	717.9	0447
0053	1381379	313494	9.5	717.9	0480
0060	1381440	313721	11.4	716.0	0513
0063	1381420	313950	9.3	718.1	0546
0070	1381406	314187	7.7	719.7	0579
0073	1381450	314413	9.4	718.0	0612
0080	1381477	314645	10.4	717.0	0645
0083	1381465	314882	9.5	717.9	0678
0090	1381450	315117	9.8	717.6	0711
0093	1381440	315356	10.0	717.4	0744
0100	1381399	315589	10.7	716.7	0777
0103	1381349	315823	10.8	716.6	0810
0110	1381338	316063	11.5	715.9	0843
0113	1381324	316300	11.3	716.1	0876
0120	1381270	316532	11.5	715.9	0909
0123	1381199	316766	12.3	715.1	0942
0130	1381144	316973	12.2	715.2	0975
0133	1381110	317224	12.4	715.0	1007
0140	1381049	317452	13.2	714.2	1040
0143	1380986	317681	12.9	714.5	1073
0150	1380934	317912	14.7	712.7	1106
0153	1380876	318148	16.3	711.1	1139
0160	1380796	318375	13.5	713.9	1172
0163	1380733	318608	12.2	715.2	1205
0170	1380679	318844	11.3	716.1	1238
0173	1380616	319077	12.0	715.4	1271
0180	1380547	319302	13.9	713.5	1304
0183	1380428	319498	13.8	713.6	1337
0190	1380279	319667	12.6	714.8	1370
0193	1380120	319826	10.7	716.7	1403
0200	1379953	319977	9.7	717.7	1436
0203	1379776	320116	10.4	717.0	1469

**WES Survey Line #4a cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Downstream

Survey Date/Time : 23 October 1994, 1518 to 1731 hours

Water Level Elevation : 727.4 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
0210	1379591	320247	12.0	715.4	1502
0213	1379422	320389	12.4	715.0	1535
0220	1379231	320519	13.1	714.3	1568
0223	1379042	320650	13.8	713.6	1601
0230	1378856	320782	13.5	713.9	1634
0233	1378665	320913	13.2	714.2	1667
0240	1378478	321044	12.6	714.8	1700
0243	1378280	321157	12.5	714.9	1733
0250	1378076	321247	11.3	716.1	1766
0253	1377878	321347	11.5	715.9	1799
0260	1377670	321423	11.3	716.1	1832
0263	1377461	321488	11.1	716.3	1865
0270	1377254	321557	11.7	715.7	1898
0273	1377035	321603	12.1	715.3	1931
0280	1376818	321627	12.6	714.8	1964
0283	1376598	321658	12.4	715.0	1997
0290	1376380	321668	10.2	717.2	2030
0293	1376161	321669	10.1	717.3	2063
0300	1375937	321665	9.2	718.2	2096
0303	1375713	321655	8.2	719.2	2129
0310	1375489	321647	9.0	718.4	2162
0313	1375267	321640	7.5	719.9	2195
0320	1375053	321621	9.8	717.6	2228
0323	1374844	321615	9.2	718.2	2261
0330	1374635	321614	9.7	717.7	2294
0333	1374424	321622	11.2	716.2	2327
0340	1374215	321602	11.2	716.2	2360
0343	1374003	321575	11.1	716.3	2393
0350	1373794	321554	11.2	716.2	2426
0353	1373588	321527	11.1	716.3	2459
0360	1373372	321486	10.5	716.9	2492
0363	1373177	321440	12.3	715.1	2525
0370	1372978	321392	14.2	713.2	2558
0373	1372782	321324	14.6	712.8	2591
0380	1372582	321275	13.3	714.1	2624
0383	1372381	321230	13.1	714.3	2657
0390	1372196	321164	11.3	716.1	2690
0393	1372004	321075	10.5	716.9	2723
0400	1371806	320986	8.9	718.5	2756
0403	1371601	320963	10.5	716.9	2789
0410	1371385	320941	10.8	716.6	2822
0413	1371173	320925	12.9	714.5	2855

**WES Survey Line #4a cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Downstream

Survey Date/Time : 23 October 1994, 1518 to 1731 hours

Water Level Elevation : 727.4 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
0420	1370969	320872	14.5	712.9	2888
0423	1370777	320836	15.4	712.0	2921
0430	1370589	320817	18.0	709.4	2954
0433	1370392	320787	19.1	708.3	2987
0440	1370195	320779	20.6	706.8	3020
0443	1370003	320760	18.9	708.5	3053
0450	1369813	320733	18.2	709.2	3086
0453	1369620	320714	18.9	708.5	3119
0460	1369430	320705	18.1	709.3	3152
0463	1369228	320714	18.2	709.2	3185
0470	1369035	320750	19.8	707.6	3218
0473	1368829	320783	22.9	704.5	3251
0480	1368623	320812	16.1	711.3	3284
0483	1368412	320842	16.7	710.7	3317
0490	1368202	320887	12.8	714.6	3350
0493	1367988	320936	13.6	713.8	3383
0500	1367787	320973	13.6	713.8	3416
0503	1367581	321022	12.0	715.4	3449
0510	1367371	321077	12.7	714.7	3482
0513	1367166	321135	12.4	715.0	3515
0520	1366954	321174	12.2	715.2	3548
0523	1366740	321225	12.0	715.4	3581
0530	1366550	321322	13.3	714.1	3614
0533	1366346	321351	13.1	714.3	3647
0540	1366134	321394	12.2	715.2	3680
0543	1365929	321457	12.8	714.6	3713
0550	1365739	321545	13.4	714.0	3746
0553	1365549	321636	13.1	714.3	3779
0560	1365346	321694	13.1	714.3	3812
0563	1365138	321741	12.9	714.5	3845
0570	1364937	321794	12.1	715.3	3878
0573	1364739	321870	12.4	715.0	3911
0580	1364551	321973	12.6	714.8	3944
0583	1364362	322060	13.3	714.1	3977
0590	1364156	322118	13.1	714.3	4010
0593	1363971	322221	12.9	714.5	4043
0600	1363802	322345	12.5	714.9	4076
0603	1363651	322474	12.0	715.4	4109
0610	1363484	322587	12.3	715.1	4142
0613	1363311	322685	12.1	715.3	4175
0620	1363146	322818	12.3	715.1	4208
0623	1362981	322960	12.4	715.0	4241

**WES Survey Line #4a cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Downstream

Survey Date/Time : 23 October 1994, 1518 to 1731 hours

Water Level Elevation : 727.4 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
0630	1362818	323115	11.9	715.5	4274
0633	1362684	323276	13.0	714.4	4307
0640	1362539	323435	12.4	715.0	4340
0643	1362398	323594	11.9	715.5	4373
0650	1362248	323760	11.9	715.5	4406
0653	1362098	323911	12.1	715.3	4439
0660	1361946	324060	12.4	715.0	4472
0663	1361788	324212	10.8	716.6	4505
0670	1361636	324361	10.8	716.6	4538
0673	1361480	324512	12.7	714.7	4571
0680	1361320	324660	12.8	714.6	4604
0683	1361197	324788	12.5	714.9	4637
0690	1361049	324913	12.7	714.7	4670
0693	1360883	325041	13.1	714.3	4705
0700	1360722	325150	12.0	715.4	4738
0703	1360554	325249	11.9	715.5	4771
0710	1360392	325353	12.0	715.4	4804
0713	1360224	325448	12.6	714.8	4837
0720	1360064	325543	12.2	715.2	4870
0723	1359891	325612	12.0	715.4	4903
0730	1359712	325681	11.3	716.1	4936
0733	1359539	325768	10.4	717.0	4969
0740	1359360	325835	11.8	715.6	5002
0743	1359176	325893	11.6	715.8	5035
0750	1358994	325951	11.7	715.7	5068
0753	1358823	326015	11.4	716.0	5101
0760	1358652	326088	11.9	715.5	5134
0763	1358481	326162	12.0	715.4	5167
0770	1358312	326228	12.7	714.7	5200
0773	1358141	326292	13.1	714.3	5233
0780	1357968	326350	14.0	713.4	5266
0783	1357794	326403	13.9	713.5	5299
0790	1357623	326461	13.7	713.7	5332
0793	1357468	326556	14.5	712.9	5365
0800	1357299	326624	14.1	713.3	5398
0803	1357134	326677	13.4	714.0	5431
0810	1356973	326736	13.7	713.7	5464
0813	1356809	326803	14.2	713.2	5497
0820	1356644	326853	13.8	713.6	5530
0823	1356465	326882	13.5	713.9	5563
0830	1356293	326904	13.2	714.2	5596
0833	1356130	326952	13.8	713.6	5629

**WES Survey Line #4a cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Downstream

Survey Date/Time : 23 October 1994, 1518 to 1731 hours

Water Level Elevation : 727.4 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
0840	1355952	326980	13.4	714.0	5662
0843	1355776	327024	13.5	713.9	5695
0850	1355598	327050	13.1	714.3	5728
0853	1355415	327081	13.1	714.3	5761
0860	1355239	327107	12.6	714.8	5794
0863	1355062	327121	12.3	715.1	5827
0870	1354884	327158	12.4	715.0	5860
0873	1354711	327205	11.3	716.1	5893
0880	1354531	327260	10.7	716.7	5926
0883	1354360	327324	12.7	714.7	5959
0890	1354199	327378	12.9	714.5	5992
0893	1354042	327464	13.3	714.1	6025
0900	1353864	327521	12.7	714.7	6058
0903	1353692	327575	13.5	713.9	6091
0910	1353537	327657	12.8	714.6	6124
0913	1353365	327703	13.4	714.0	6157
0920	1353184	327713	13.9	713.5	6190
0923	1353014	327784	14.2	713.2	6223
0930	1352852	327867	14.4	713.0	6256
0933	1352696	327971	14.3	713.1	6289
0940	1352530	328034	14.7	712.7	6322
0943	1352359	328108	14.5	712.9	6355
0950	1352190	328199	14.1	713.3	6388
0953	1352038	328324	15.4	712.0	6421
0960	1351912	328475	17.1	710.3	6454
0963	1351796	328637	15.2	712.2	6487
0970	1351685	328794	14.0	713.4	6520
0973	1351548	328927	13.7	713.7	6553
0980	1351398	329055	12.8	714.6	6586
0983	1351248	329185	11.8	715.6	6619
0990	1351110	329329	12.4	715.0	6652
0993	1350989	329485	12.7	714.7	6685
1000	1350858	329638	14.7	712.7	6718
1003	1350734	329787	13.7	713.7	6751
1010	1350608	329935	13.9	713.5	6784
1013	1350486	330090	13.6	713.8	6817
1020	1350366	330245	13.6	713.8	6850
1023	1350249	330404	15.1	712.3	6883
1030	1350127	330566	15.0	712.4	6916
1033	1349994	330720	14.2	713.2	6949
1040	1349875	330868	14.5	712.9	6982
1043	1349748	331009	14.3	713.1	7015

WES Survey Line #4a cont.
Pool #3, Monongahela River, Pennsylvania

Survey Direction : Downstream

Survey Date/Time : 23 October 1994, 1518 to 1731 hours

Water Level Elevation : 727.4 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
1050	1349628	331147	14.1	713.3	7048
1053	1349528	331303	14.6	712.8	7081
1060	1349410	331448	15.0	712.4	7114
1063	1349283	331588	14.9	712.5	7147
1070	1349159	331737	16.7	710.7	7180
1073	1349022	331878	14.0	713.4	7213
1080	1348911	332032	19.6	707.8	7246
1083	1348802	332188	16.1	711.3	7279
1090	1348692	332341	16.4	711.0	7312
1093	1348584	332499	15.3	712.1	7345
1100	1348479	332663	14.1	713.3	7378
1103	1348407	332841	13.7	713.7	7411
1110	1348360	333020	14.5	712.9	7444
1113	1348309	333201	16.0	711.4	7477
1120	1348271	333384	17.3	710.1	7510
1123	1348227	333574	15.4	712.0	7543
1130	1348192	333771	14.3	713.1	7576
1133	1348175	333972	16.5	710.9	7609
1140	1348163	334175	16.0	711.4	7642
1143	1348171	334380	16.6	710.8	7675
1150	1348197	334583	16.9	710.5	7708
1153	1348244	334778	17.7	709.7	7741
1160	1348305	334971	17.2	710.2	7774
1163	1348369	335164	11.9	715.5	7807
1170	1348426	335362	14.6	712.8	7840
1173	1348500	335551	17.1	710.3	7873
1180	1348611	335723	18.1	709.3	7906
1183	1348737	335891	18.5	708.9	7939
1190	1348848	336059	19.8	707.6	7971
1193	1348959	336226	20.9	706.5	8004
1200	1349076	336383	19.8	707.6	8037
1203	1349197	336544	21.0	706.4	8070
1210	1349335	336696	20.4	707.0	8103

**WES Survey Line #4b
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Downstream
Survey Date/Time : 24 October 1994, 1018 to 1121 hours

Water Level Elevation : 727.9 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
0000	1348249	333753	18.9	709.0	0107
0003	1348188	333963	18.0	709.9	0140
0010	1348178	334184	17.7	710.2	0173
0013	1348199	334410	17.9	710.0	0206
0020	1348228	334635	18.4	709.5	0239
0023	1348270	334856	17.3	710.6	0272
0030	1348341	335068	15.6	712.3	0305
0033	1348411	335282	14.6	713.3	0338
0040	1348495	335483	16.4	711.5	0371
0043	1348593	335679	20.5	707.4	0404
0050	1348724	335864	19.1	708.8	0437
0053	1348839	336053	20.1	707.8	0470
0060	1348936	336250	19.5	708.4	0503
0063	1349062	336432	15.2	712.7	0536
0070	1349206	336595	16.9	711.0	0569
0073	1349332	336777	11.2	716.7	0602
0080	1349488	336930	12.6	715.3	0635
0083	1349651	337078	15.4	712.5	0668
0090	1349810	337221	16.2	711.7	0701
0093	1349965	337364	12.3	715.6	0734
0100	1350147	337477	17.9	710.0	0767
0103	1350327	337606	19.5	708.4	0800
0110	1350513	337725	13.9	714.0	0833
0113	1350724	337799	17.7	710.2	0866
0120	1350930	337881	12.1	715.8	0899
0123	1351112	337995	14.7	713.2	0931
0130	1351308	338087	12.2	715.7	0964
0133	1351519	338157	9.0	718.9	0997
0140	1351731	338208	14.4	713.5	1030
0143	1351931	338284	9.7	718.2	1062
0150	1352137	338332	16.0	711.9	1094
0153	1352357	338355	19.1	708.8	1127
0160	1352573	338397	18.2	709.7	1160
0163	1352784	338467	16.3	711.6	1193
0170	1353004	338495	16.3	711.6	1226
0173	1353226	338510	16.6	711.3	1259
0180	1353445	338492	17.8	710.1	1292
0183	1353664	338473	18.0	709.9	1325
0190	1353880	338445	19.5	708.4	1358
0193	1354104	338448	17.8	710.1	1391
0200	1354324	338481	16.6	711.3	1424
0203	1354543	338526	18.0	709.9	1457

**WES Survey Line #4b cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Downstream

Survey Date/Time : 24 October 1994, 1018 to 1121 hours

Water Level Elevation : 727.9 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
0210	1354765	338541	17.0	710.9	1490
0213	1354987	338546	17.1	710.8	1523
0220	1355208	338543	22.9	705.0	1556
0223	1355429	338526	22.3	705.6	1589
0230	1355651	338536	17.3	710.6	1622
0233	1355871	338557	18.0	709.9	1655
0240	1356092	338542	17.5	710.4	1688
0243	1356311	338514	15.3	712.6	1721
0250	1356532	338510	15.9	712.0	1754
0253	1356750	338531	15.0	712.9	1787
0260	1356968	338559	14.4	713.5	1820
0263	1357190	338556	14.9	713.0	1853
0270	1357410	338567	14.1	713.8	1886
0273	1357630	338590	14.8	713.1	1919
0280	1357848	338630	13.3	714.6	1952
0283	1358066	338668	13.5	714.4	1985
0290	1358290	338682	13.4	714.5	2018
0293	1358508	338711	13.1	714.8	2051
0300	1358728	338746	12.6	715.3	2084
0303	1358952	338763	13.0	714.9	2117
0310	1359173	338795	13.3	714.6	2150
0313	1359385	338859	12.6	715.3	2183
0320	1359588	338947	12.1	715.8	2216
0323	1359794	339028	11.2	716.7	2249
0330	1360003	339106	10.4	717.5	2282
0333	1360218	339172	11.3	716.6	2315
0340	1360428	339242	10.7	717.2	2348
0343	1360628	339336	10.9	717.0	2381
0350	1360824	339417	11.9	716.0	2413
0353	1361039	339483	12.6	715.3	2446
0360	1361242	339592	13.1	714.8	2479
0363	1361426	339711	13.3	714.6	2512
0370	1361591	339854	13.2	714.7	2545
0373	1361761	339990	12.5	715.4	2578
0380	1361941	340115	12.9	715.0	2611
0383	1362129	340222	13.0	714.9	2644
0390	1362308	340341	13.4	714.5	2677
0393	1362488	340466	13.4	714.5	2710
0400	1362670	340582	14.1	713.8	2743
0403	1362854	340702	13.5	714.4	2776
0410	1363026	340829	13.4	714.5	2809
0413	1363195	340970	14.1	713.8	2842

**WES Survey Line #4b cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Downstream

Survey Date/Time : 24 October 1994, 1018 to 1121 hours

Water Level Elevation : 727.9 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
0420	1363359	341122	12.7	715.2	2875
0423	1363514	341278	13.5	714.4	2908
0430	1363661	341445	14.6	713.3	2941
0433	1363810	341609	12.8	715.1	2974
0440	1363954	341774	13.6	714.3	3007
0443	1364084	341940	14.3	713.6	3040
0450	1364226	342093	14.8	713.1	3073
0453	1364366	342245	16.4	711.5	3106
0460	1364498	342403	18.1	709.8	3139
0463	1364590	342598	16.4	711.5	3172
0470	1364644	342818	13.2	714.7	3205
0473	1364718	343041	12.9	715.0	3238
0480	1364846	343233	14.7	713.2	3271
0483	1364991	343408	14.9	713.0	3304
0490	1365098	343599	17.1	710.8	3337
0493	1365199	343791	16.8	711.1	3370
0500	1365308	343982	17.4	710.5	3403
0503	1365434	344161	17.1	710.8	3436
0510	1365578	344328	15.6	712.3	3469
0513	1365725	344496	17.0	710.9	3502
0520	1365884	344657	18.6	709.3	3535
0523	1366052	344809	21.4	706.5	3568
0530	1366234	344947	22.3	705.6	3601
0533	1366423	345078	21.3	706.6	3634
0540	1366533	345124	19.1	708.8	3667
0543	1366781	345355	18.8	709.1	3700
0550	1366957	345502	18.3	709.6	3733
0553	1367129	345654	18.8	709.1	3766
0560	1367307	345797	19.4	708.5	3799
0563	1367490	345938	19.7	708.2	3832

Appendix E

Survey Line #5

Positioning Information

WES Survey Line #5
Pool #3, Monongahela River, Pennsylvania

Survey Direction : Upstream
Survey Date/Time : 24 October 1994, 1233 to 1549 hours

Water Level Elevation : 727.7 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
0000	1367596	345579	13.0	714.7	0196
0003	1367443	345442	13.5	714.2	0230
0010	1367295	345295	13.4	714.3	0263
0013	1367136	345162	12.6	715.1	0296
0020	1366971	345035	14.4	713.3	0329
0023	1366808	344904	15.8	711.9	0362
0030	1366646	344775	15.9	711.8	0395
0033	1366491	344640	14.6	713.1	0428
0040	1366345	344498	12.4	715.3	0461
0043	1366203	344353	18.6	709.1	0494
0050	1366070	344213	15.1	712.6	0527
0053	1365942	344064	14.0	713.7	0560
0060	1365813	343914	11.6	716.1	0593
0063	1365684	343765	14.0	713.7	0626
0070	1365550	343627	15.4	712.3	0659
0073	1365428	343481	23.6	704.1	0692
0080	1365311	343330	24.6	703.1	0725
0083	1365222	343161	19.8	707.9	0758
0090	1365170	342970	16.4	711.3	0791
0093	1365101	342780	16.4	711.3	0824
0100	1365028	342580	13.9	713.8	0857
0103	1364926	342395	14.1	713.6	0890
0110	1364780	342252	15.6	712.1	0923
0113	1364667	342079	15.5	712.2	0956
0120	1364607	341886	17.1	710.6	0989
0123	1364534	341699	17.0	710.7	1022
0130	1364404	341545	16.6	711.1	1055
0133	1364262	341402	20.7	707.0	1088
0140	1364108	341267	23.4	704.3	1121
0143	1363958	341139	18.5	709.2	1154
0150	1363769	340990	16.8	710.9	1187
0153	1363592	340817	17.0	710.7	1220
0160	1363423	340632	17.2	710.5	1253
0163	1363251	340451	17.2	710.5	1286
0170	1363035	340326	16.8	710.9	1319
0173	1362808	340224	16.7	711.0	1352
0180	1362603	340095	16.4	711.3	1385
0183	1362420	339927	15.6	712.1	1418
0190	1362222	339776	15.8	711.9	1451
0193	1362010	339645	15.3	712.4	1484
0200	1361796	339528	15.7	712.0	1517
0203	1361583	339415	15.0	712.7	1550

**WES Survey Line #5 cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Upstream
Survey Date/Time : 24 October 1994, 1233 to 1549 hours

Water Level Elevation : 727.7 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
0210	1361369	339294	17.2	710.5	1583
0213	1361165	339147	17.1	710.6	1616
0220	1360961	338998	16.6	711.1	1649
0223	1360739	338880	17.2	710.5	1682
0230	1360508	338774	17.2	710.5	1715
0233	1360265	338697	15.8	711.9	1748
0240	1360019	338631	16.3	711.4	1781
0243	1359772	338559	16.3	711.4	1814
0250	1359521	338496	17.6	710.1	1847
0253	1359270	338428	17.1	710.6	1880
0260	1359024	338356	17.5	710.2	1913
0263	1358773	338307	16.6	711.1	1946
0270	1358520	338248	16.8	710.9	1979
0273	1358264	338225	17.4	710.3	2012
0280	1358010	338216	16.6	711.1	2045
0283	1357752	338207	16.6	711.1	2078
0290	1357492	338215	16.7	711.0	2111
0293	1357236	338184	16.3	711.4	2144
0300	1356981	338137	14.6	713.1	2177
0303	1356723	338109	14.8	712.9	2210
0310	1356465	338111	15.6	712.1	2243
0313	1356210	338116	15.8	711.9	2276
0320	1355956	338122	16.7	711.0	2309
0323	1355706	338106	15.8	711.9	2342
0330	1355455	338092	16.4	711.3	2375
0333	1355201	338093	16.0	711.7	2408
0340	1354948	338104	13.9	713.8	2441
0343	1354699	338106	14.3	713.4	2474
0350	1354449	338085	14.5	713.2	2507
0353	1354199	338068	13.5	714.2	2540
0360	1353948	338061	11.8	715.9	2573
0363	1353696	338047	11.6	716.1	2606
0370	1353442	338046	12.6	715.1	2639
0373	1353190	338023	12.2	715.5	2672
0380	1352937	338017	13.0	714.7	2705
0383	1352687	338004	13.9	713.8	2738
0390	1352441	337954	13.2	714.5	2771
0393	1352198	337895	12.5	715.2	2804
0400	1351953	337860	13.8	713.9	2837
0403	1351715	337803	13.6	714.1	2870
0410	1351480	337717	15.1	712.6	2903
0413	1351250	337634	13.9	713.8	2936

**WES Survey Line #5 cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Upstream
Survey Date/Time : 24 October 1994, 1233 to 1549 hours

Water Level Elevation : 727.7 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
0420	1351026	337524	13.1	714.6	2969
0423	1350808	337407	12.6	715.1	3002
0430	1350590	337285	11.7	716.0	3035
0433	1350376	337161	12.4	715.3	3068
0440	1350174	337017	12.2	715.5	3101
0443	1349986	336856	12.2	715.5	3134
0450	1349816	336680	11.7	716.0	3167
0453	1349639	336508	12.7	715.0	3200
0460	1349479	336320	11.8	715.9	3233
0463	1349335	336117	11.8	715.9	3266
0470	1349206	335896	11.0	716.7	3299
0473	1349085	335672	11.2	716.5	3332
0480	1348977	335444	10.4	717.3	3365
0483	1348880	335208	9.0	718.7	3398
0490	1348786	334975	8.5	719.2	3431
0493	1348704	334742	9.7	718.0	3464
0500	1348644	334499	10.6	717.1	3497
0503	1348634	334248	12.0	715.7	3530
0510	1348643	334000	11.3	716.4	3563
0513	1348626	333755	13.4	714.3	3596
0520	1348588	333514	16.5	711.2	3629
0523	1348682	333294	16.3	711.4	3662
0530	1348803	333076	14.7	713.0	3695
0533	1348908	332847	13.3	714.4	3728
0540	1349015	332612	14.0	713.7	3761
0543	1349150	332394	15.4	712.3	3794
0550	1349296	332182	16.6	711.1	3827
0553	1349468	331994	14.6	713.1	3860
0560	1349629	331789	17.3	710.4	3893
0563	1349814	331608	17.4	710.3	3926
0570	1349982	331410	16.5	711.2	3959
0573	1350126	331195	16.0	711.7	3992
0580	1350300	331000	14.8	712.9	4025
0583	1350450	330784	12.8	714.9	4058
0590	1350637	330604	12.9	714.8	4091
0593	1350807	330407	11.1	716.6	4124
0600	1350955	330188	10.2	717.5	4157
0603	1351101	329974	10.1	717.6	4190
0610	1351258	329771	10.2	717.5	4223
0613	1351426	329577	10.4	717.3	4256
0620	1351620	329404	10.0	717.7	4289
0623	1351785	329209	10.9	716.8	4322

**WES Survey Line #5 cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Upstream

Survey Date/Time : 24 October 1994, 1233 to 1549 hours

Water Level Elevation : 727.7 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
0630	1351948	329003	11.3	716.4	4355
0633	1352123	328814	12.0	715.7	4388
0640	1352323	328644	13.5	714.2	4421
0643	1352526	328482	13.5	714.2	4454
0650	1352764	328377	15.5	712.2	4487
0653	1352998	328263	12.6	715.1	4520
0660	1353245	328190	15.2	712.5	4553
0663	1353495	328113	13.7	714.0	4586
0670	1353731	328000	13.1	714.6	4619
0673	1353976	327910	15.1	712.6	4652
0680	1354230	327845	14.4	713.3	4685
0683	1354486	327785	12.0	715.7	4718
0690	1354738	327719	13.2	714.5	4751
0693	1354990	327647	13.6	714.1	4784
0700	1355242	327571	10.8	716.9	4817
0703	1355489	327489	13.7	714.0	4850
0710	1355730	327415	14.9	712.8	4882
0713	1355971	327330	16.4	711.3	4915
0720	1356201	327227	16.2	711.5	4948
0723	1356456	327202	15.6	712.1	4981
0730	1357418	326953	14.0	713.7	5108
0733	1357682	326855	14.2	713.5	5144
0740	1357950	326763	13.6	714.1	5180
0743	1358237	326706	12.4	715.3	5217
0750	1358501	326612	12.4	715.3	5253
0753	1358762	326501	13.1	714.6	5289
0760	1359026	326402	12.8	714.9	5325
0763	1359293	326328	10.8	716.9	5361
0770	1359548	326221	13.1	714.6	5397
0773	1359812	326090	12.8	714.9	5433
0780	1360055	325955	16.1	711.6	5469
0783	1360293	325813	17.1	710.6	5505
0790	1360539	325682	17.9	709.8	5541
0793	1360790	325555	17.2	710.5	5577
0800	1361040	325423	16.0	711.7	5613
0803	1361281	325255	14.6	713.1	5650
0810	1361457	325035	11.5	716.2	5686
0813	1361637	324832	11.2	716.5	5722
0820	1361828	324626	11.1	716.6	5758
0823	1362015	324418	11.3	716.4	5794
0830	1362212	324212	9.1	718.6	5830
0833	1362427	324030	10.4	717.3	5866

WES Survey Line #5 cont.
Pool #3, Monongahela River, Pennsylvania

Survey Direction : Upstream
 Survey Date/Time : 24 October 1994, 1233 to 1549 hours

Water Level Elevation : 727.7 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
0840	1362642	323834	10.0	717.7	5903
0843	1362833	323624	10.1	717.6	5939
0850	1363024	323412	10.4	717.3	5975
0853	1363215	323204	10.4	717.3	6011
0860	1363412	322995	11.3	716.4	6047
0863	1363628	322819	11.1	716.6	6083
0870	1363881	322700	11.0	716.7	6119
0873	1364140	322598	10.3	717.4	6155
0880	1364404	322488	10.4	717.3	6191
0883	1364674	322378	10.3	717.4	6227
0890	1364925	322238	11.0	716.7	6263
0893	1365180	322112	10.8	716.9	6299
0900	1365443	322006	10.2	717.5	6335
0903	1365707	321882	9.9	717.8	6371
0910	1365981	321762	10.7	717.0	6407
0913	1366268	321748	9.6	718.1	6443
0920	1366557	321706	9.9	717.8	6480
0923	1366844	321667	10.3	717.4	6516
0930	1367124	321610	10.5	717.2	6552
0933	1367400	321528	11.4	716.3	6588
0940	1367679	321452	10.8	716.9	6624
0943	1367961	321395	9.1	718.6	6660
0950	1368245	321331	7.4	720.3	6696
0953	1368524	321241	9.2	718.5	6732
0960	1368797	321138	12.8	714.9	6768
0963	1369088	321102	13.5	714.2	6804
0970	1369389	321094	12.7	715.0	6840
0973	1369679	321100	13.9	713.8	6876
0980	1369971	321117	14.7	713.0	6912
0983	1370260	321154	14.1	713.6	6948
0990	1370547	321214	15.4	712.3	6984
0993	1370838	321256	12.2	715.5	7020
1000	1371135	321290	14.2	713.5	7056
1003	1371416	321343	20.7	707.0	7092
1010	1371694	321407	16.6	711.1	7128
1013	1371969	321491	11.7	716.0	7164
1020	1372248	321561	11.9	715.8	7200
1023	1372511	321668	14.4	713.3	7236
1030	1372780	321763	14.0	713.7	7272
1033	1373056	321823	12.3	715.4	7308
1040	1373329	321899	13.9	713.8	7344
1043	1373617	321914	13.6	714.1	7380

**WES Survey Line #5 cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Upstream

Survey Date/Time : 24 October 1994, 1233 to 1549 hours

Water Level Elevation : 727.7 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
1050	1373906	321956	12.2	715.5	7416
1053	1374220	321983	12.8	714.9	7452
1060	1374521	322001	13.8	713.9	7488
1063	1374811	322033	13.3	714.4	7524
1070	1375108	322064	12.2	715.5	7561
1073	1375401	322073	12.3	715.4	7597
1080	1375693	322068	11.6	716.1	7633
1083	1375993	322053	12.8	714.9	7670
1090	1376283	322043	12.6	715.1	7706
1093	1376569	321984	12.1	715.6	7742
1100	1376870	321989	12.3	715.4	7779
1103	1377160	322010	12.1	715.6	7815
1110	1377442	321946	12.6	715.1	7851
1113	1377724	321871	13.1	714.6	7887
1120	1377983	321749	13.7	714.0	7923
1123	1378220	321590	14.7	713.0	7959
1130	1378494	321468	13.4	714.3	7996
1133	1378745	321325	13.9	713.8	8032
1140	1378980	321157	14.4	713.3	8068
1143	1379219	320992	12.8	714.9	8104
1150	1379445	320821	10.6	717.1	8140
1153	1379638	320619	13.9	713.8	8176
1160	1379869	320442	16.0	711.7	8212
1163	1380110	320281	13.8	713.9	8248
1170	1380336	320095	12.3	715.4	8284
1173	1380548	319896	12.2	715.5	8320
1180	1380729	319674	15.4	712.3	8356
1183	1380868	319422	14.8	712.9	8392
1190	1380985	319165	15.2	712.5	8428
1193	1381070	318893	15.3	712.4	8465
1200	1381140	318616	15.0	712.7	8501
1203	1381200	318331	14.0	713.7	8538
1210	1381242	318049	12.4	715.3	8574
1213	1381287	317766	11.4	716.3	8610
1220	1381340	317487	11.2	716.5	8646
1223	1381395	317209	11.9	715.8	8682
1230	1381468	317054	12.1	715.6	8718
1233	1381540	316659	13.9	713.8	8754
1240	1381597	316382	13.7	714.0	8790
1243	1381646	316103	15.2	712.5	8826
1250	1381662	315823	13.8	713.9	8862
1253	1381694	315539	17.4	710.3	8898

WES Survey Line #5 cont.
Pool #3, Monongahela River, Pennsylvania

Survey Direction : Upstream
Survey Date/Time : 24 October 1994, 1233 to 1549 hours

Water Level Elevation : 727.7 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
1260	1381732	315262	15.4	712.3	8934
1263	1381762	314972	12.5	715.2	8970
1270	1381791	314678	12.7	715.0	9007
1273	1381816	314391	13.4	714.3	9043
1280	1381850	314112	17.6	710.1	9079
1283	1381826	313821	11.6	716.1	9117
1290	1381775	313541	13.9	713.8	9153
1293	1381717	313263	14.9	712.8	9189
1300	1381638	312991	17.9	709.8	9226
1303	1381542	312735	18.0	709.7	9262
1310	1381453	312480	17.2	710.5	9298
1313	1381408	312213	16.0	711.7	9334
1320	1381321	311962	13.9	713.8	9370
1323	1381202	311719	15.3	712.4	9406
1330	1381062	311484	15.6	712.1	9442
1333	1380937	311236	15.1	712.6	9479
1340	1380820	310992	15.7	712.0	9515
1343	1380657	310767	15.5	712.2	9552
1350	1380477	310538	13.3	714.4	9589
1353	1380307	310322	16.2	711.5	9625
1360	1380140	310106	10.0	717.7	9661
1363	1379929	309935	16.3	711.4	9697
1370	1379737	309743	15.3	712.4	9733
1373	1379538	309563	16.2	711.5	9769
1380	1379315	309398	15.1	712.6	9805
1383	1379062	309269	15.0	712.7	9841
1390	1378812	309147	14.7	713.0	9877
1393	1378583	309020	11.8	715.9	9914
1400	1378315	308891	11.7	716.0	9950
1403	1378059	308797	13.5	714.2	9986
1410	1377792	308685	12.0	715.7	0024
1413	1377511	308700	14.0	713.7	0061
1420	1377225	308710	15.1	712.6	0098
1423	1376949	308751	12.4	715.3	0134
1430	1376673	308795	12.5	715.2	0170
1433	1376388	308826	11.3	716.4	0207
1440	1376105	308866	11.6	716.1	0243
1443	1375822	308918	12.7	715.0	0279
1450	1375551	308986	12.0	715.7	0315
1453	1375280	309079	12.4	715.3	0352
1460	1375013	309156	10.5	717.2	0388
1463	1374730	309170	11.5	716.2	0424

**WES Survey Line #5 cont.
Pool #3, Monongahela River, Pennsylvania**

Survey Direction : Upstream

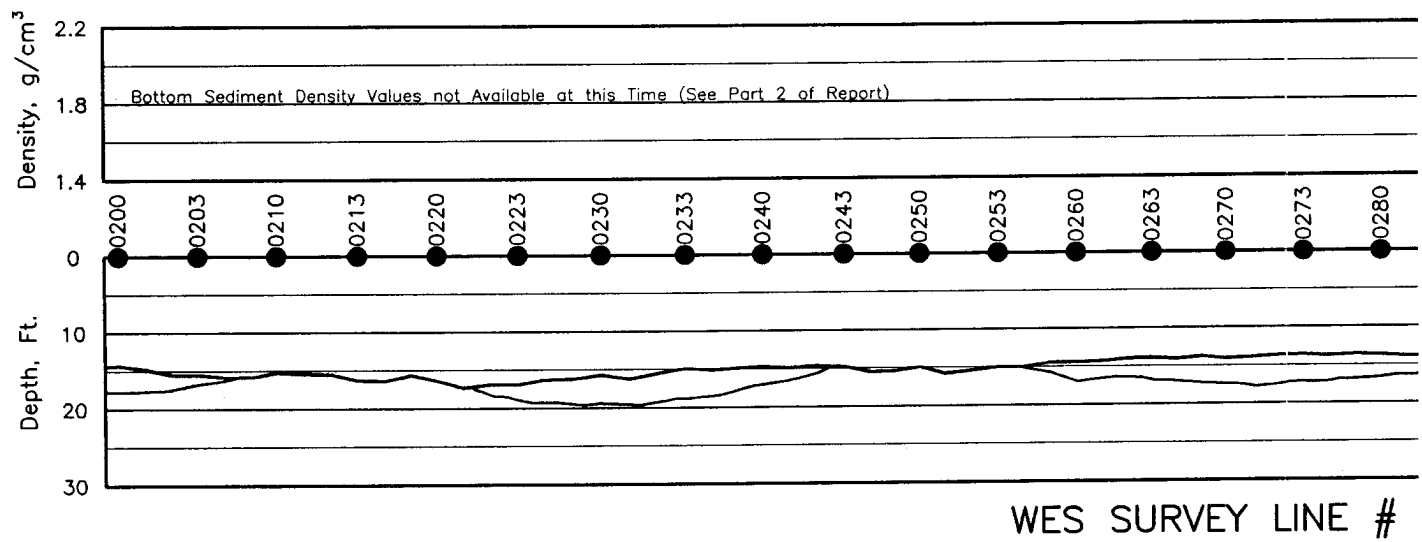
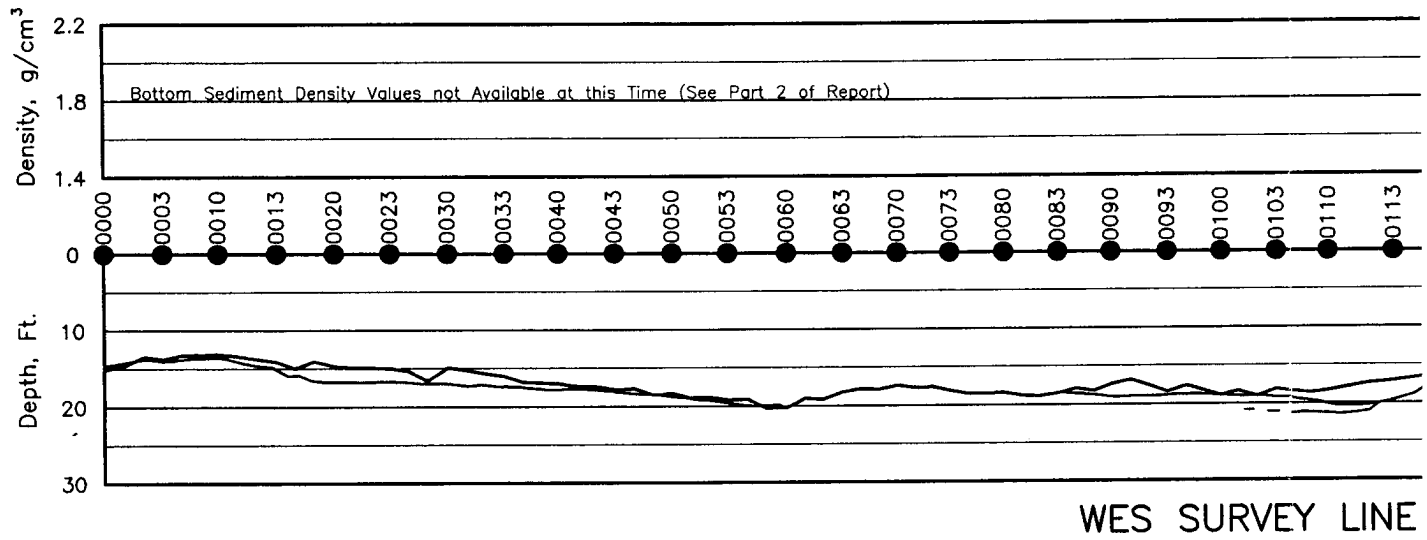
Survey Date/Time : 24 October 1994, 1233 to 1549 hours

Water Level Elevation : 727.7 ft MSL Above Lock and Dam 3

<u>File #</u>	<u>Easting</u>	<u>Northing</u>	<u>Water Depth, ft</u>	<u>River Bottom Elevation, ft MSL</u>	<u>Fix Point</u>
1470	1374444	309239	10.9	716.8	0461
1473	1374168	309321	10.8	716.9	0498
1480	1373908	309394	10.7	717.0	0535
1483	1373632	309456	11.2	716.5	0572
1490	1373363	309535	12.0	715.7	0608
1493	1373087	309597	11.7	716.0	0644
1500	1372818	309680	13.1	714.6	0680
1503	1372543	309745	13.3	714.4	0716
1510	1372269	309807	14.0	713.7	0752
1513	1371992	309891	13.7	714.0	0789
1520	1371718	309971	13.1	714.6	0825
1523	1371438	310018	9.8	717.9	0861
1530	1371159	310030	9.2	718.5	0897
1533	1370870	310065	9.3	718.4	0934
1540	1370595	310097	11.0	716.7	0970
1543	1370321	310120	10.1	717.6	1006
1550	1370046	310120	10.5	717.2	1042
1553	1369766	310113	10.8	716.9	1078
1560	1369485	310064	10.4	717.3	1115
1563	1369200	310060	11.0	716.7	1152
1570	1368931	309994	9.3	718.4	1188
1573	1368663	309925	10.5	717.2	1224
1580	1368419	309788	9.7	718.0	1260
1583	1368166	309654	10.1	717.6	1297
1590	1367908	309509	10.5	717.2	1334
1593	1367705	309304	8.8	718.9	1370
1600	1367498	309109	8.9	718.8	1406
1603	1367280	308923	10.0	717.7	1442
1610	1367073	308731	10.2	717.5	1478
1613	1366903	308499	9.9	717.8	1515
1620	1366781	308249	8.5	719.2	1551
1623	1366660	308004	8.2	719.5	1587
1630	1366529	307764	8.2	719.5	1623
1633	1366446	307506	8.6	719.1	1659
1640	1366330	307254	10.9	716.8	1696
1643	1366341	306986	11.6	716.1	1732
1650	1366347	306712	9.9	717.8	1768
1653	1366375	306438	10.4	717.3	1804
1660	1366434	306163	11.5	716.2	1840
1663	1366506	305888	10.7	717.0	1876
1670	1366609	305632	11.0	716.7	1913

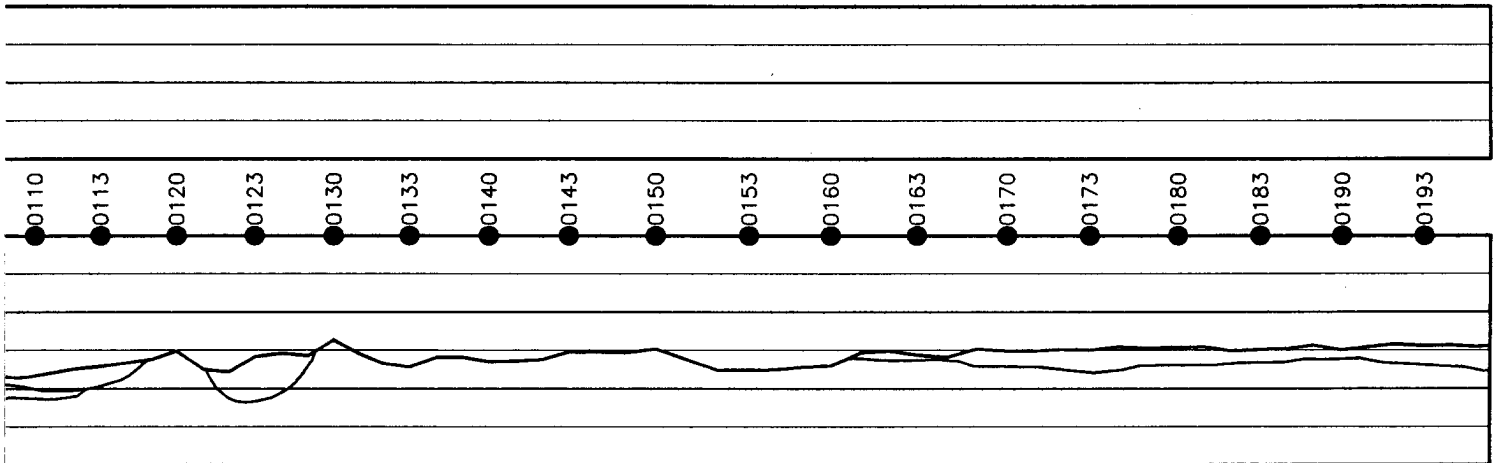
Appendix F

River Bottom Depth Profiles

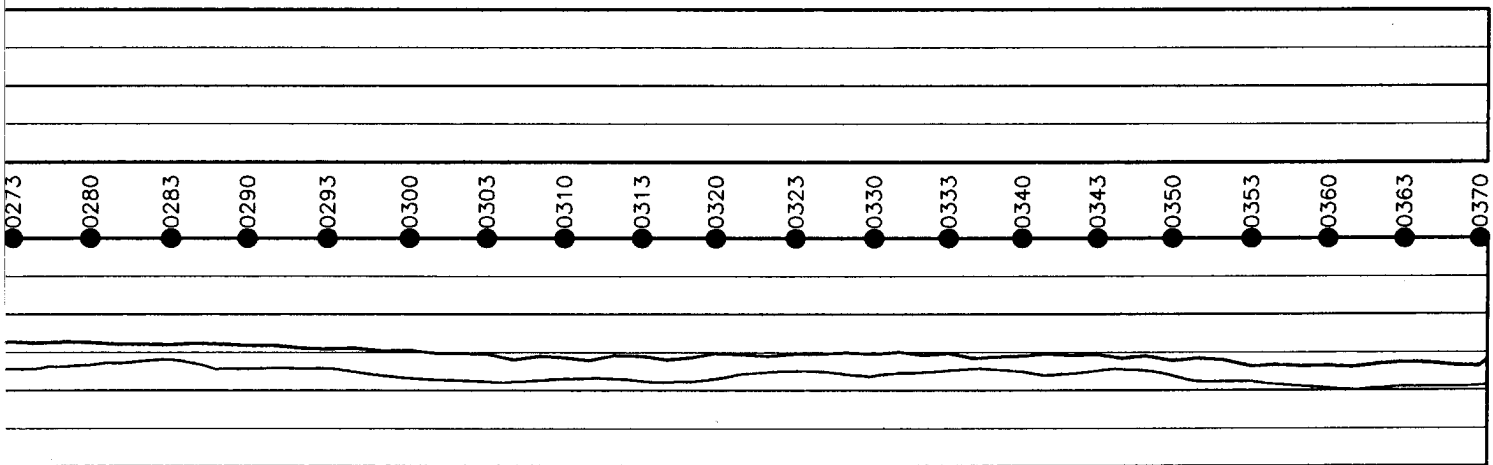


PROJECT AREA: POOL 3 NAVIGATION CHANNEL, MONONGAHELA RIVER, PA

2

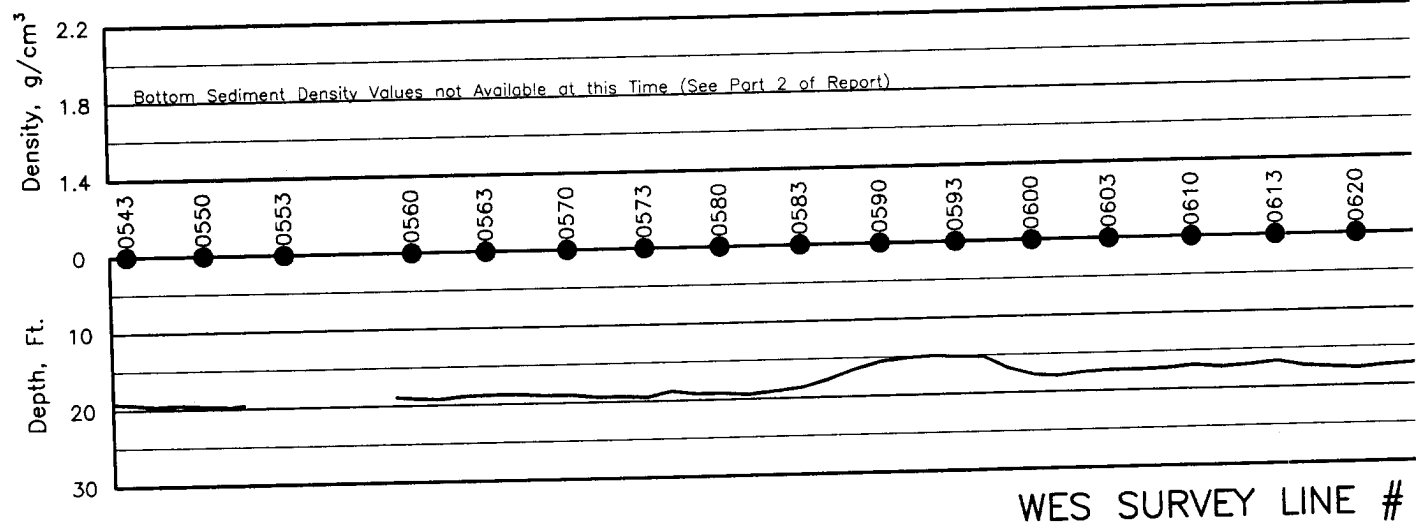
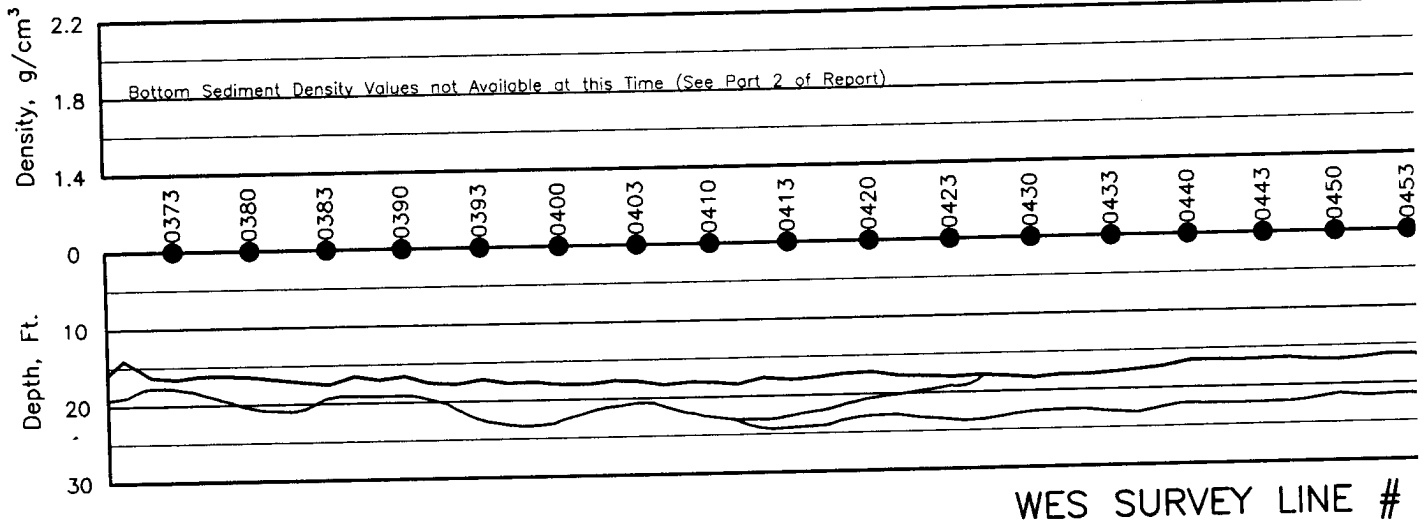


Y LINE # PP1A



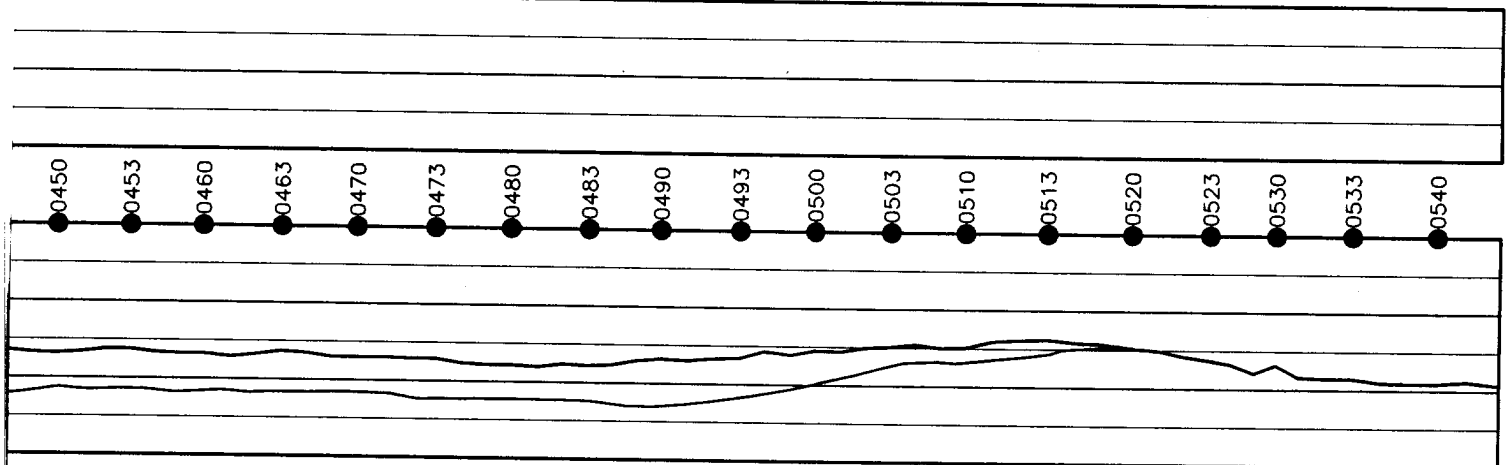
NE # PP1A (cont)

Vertical Exaggeration X 2

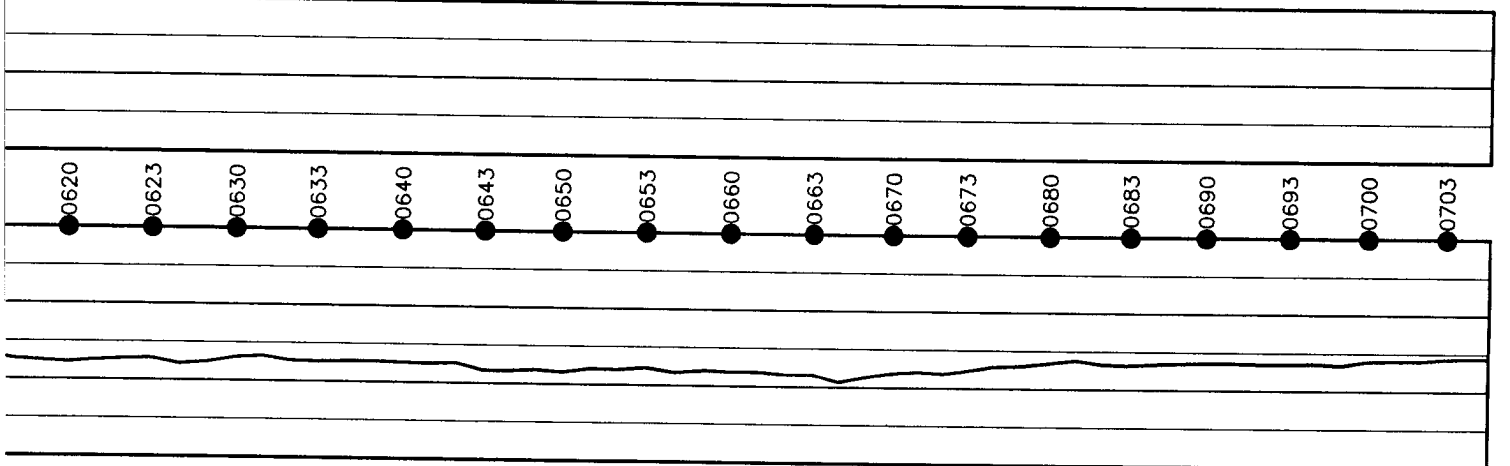


PROJECT AREA: POOL 3 NAVIGATION CHANNEL, MONONGAHELA RIVER, PA

2

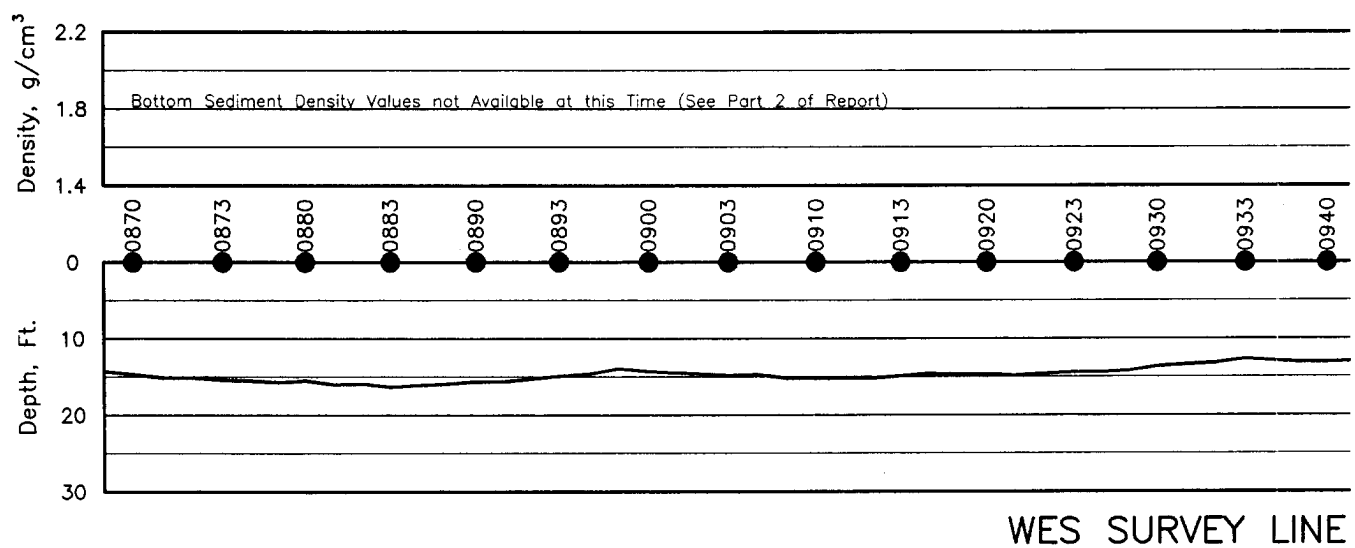
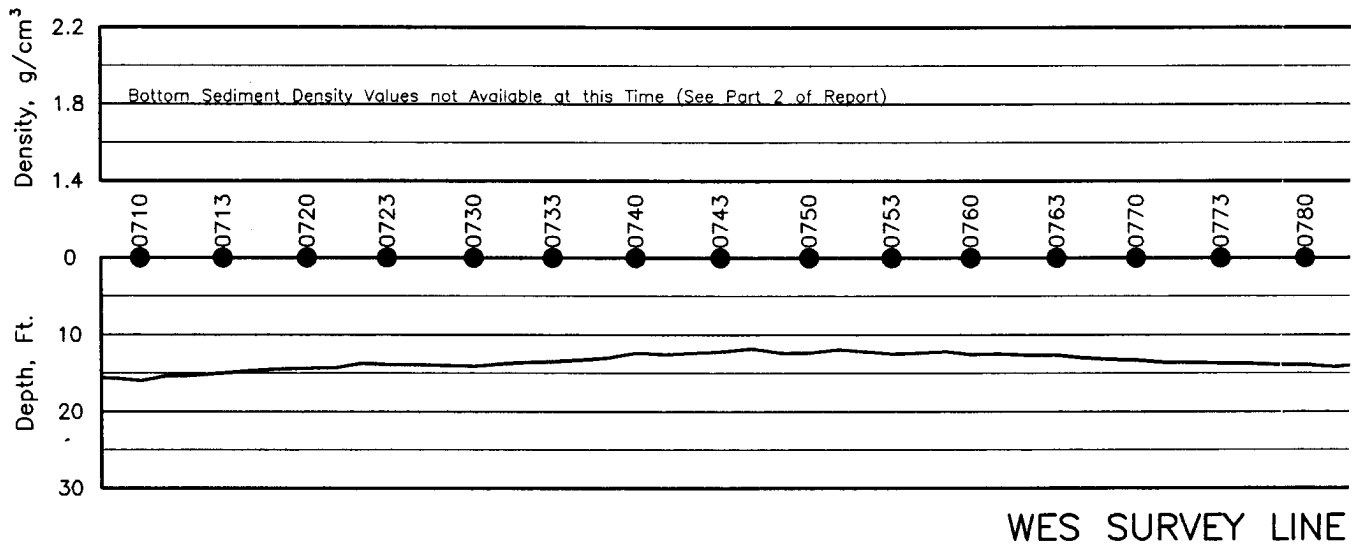


LINE # PP1A (cont)



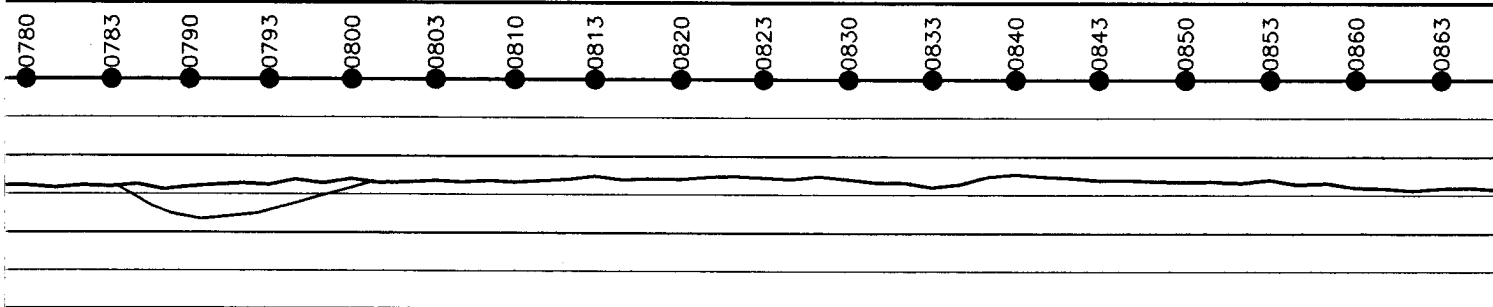
LINE # PP1A (cont)

Vertical Exaggeration X 2

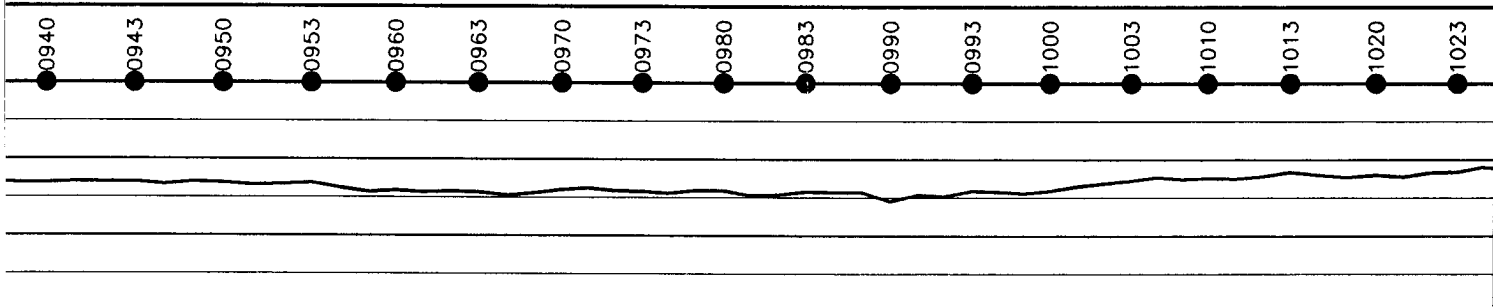


PROJECT AREA: POOL 3 NAVIGATION CHANNEL, MONONGAHELA RIVER,

2

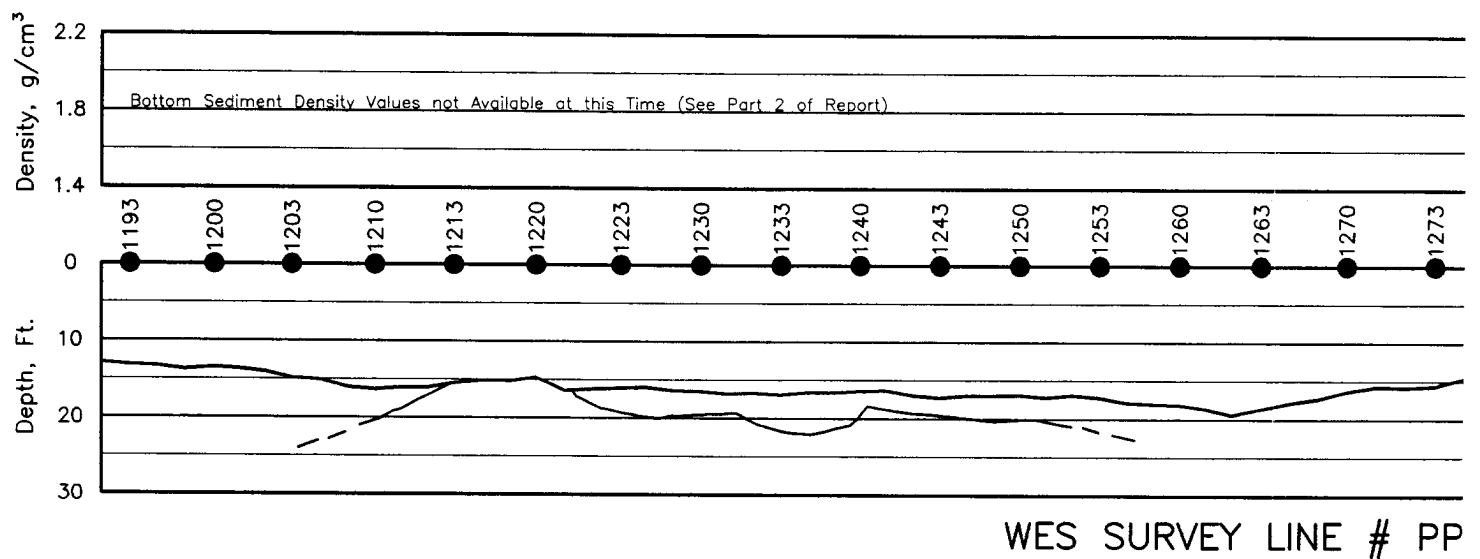
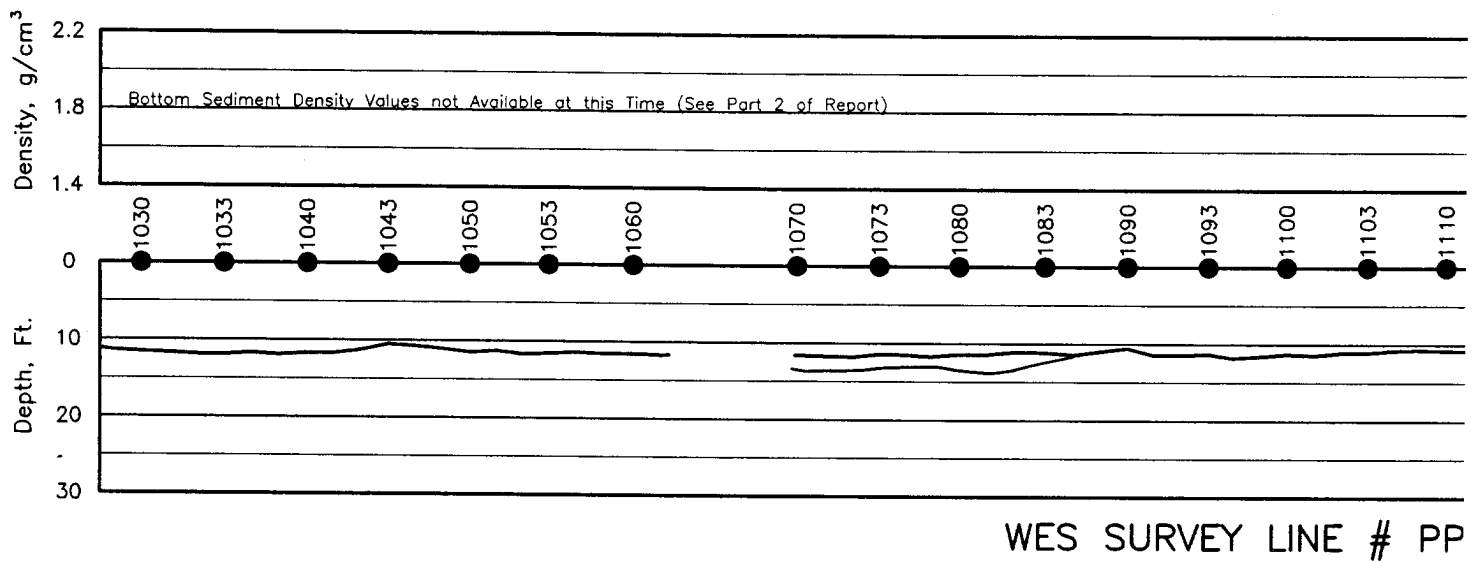


LINE # PP1A (cont)



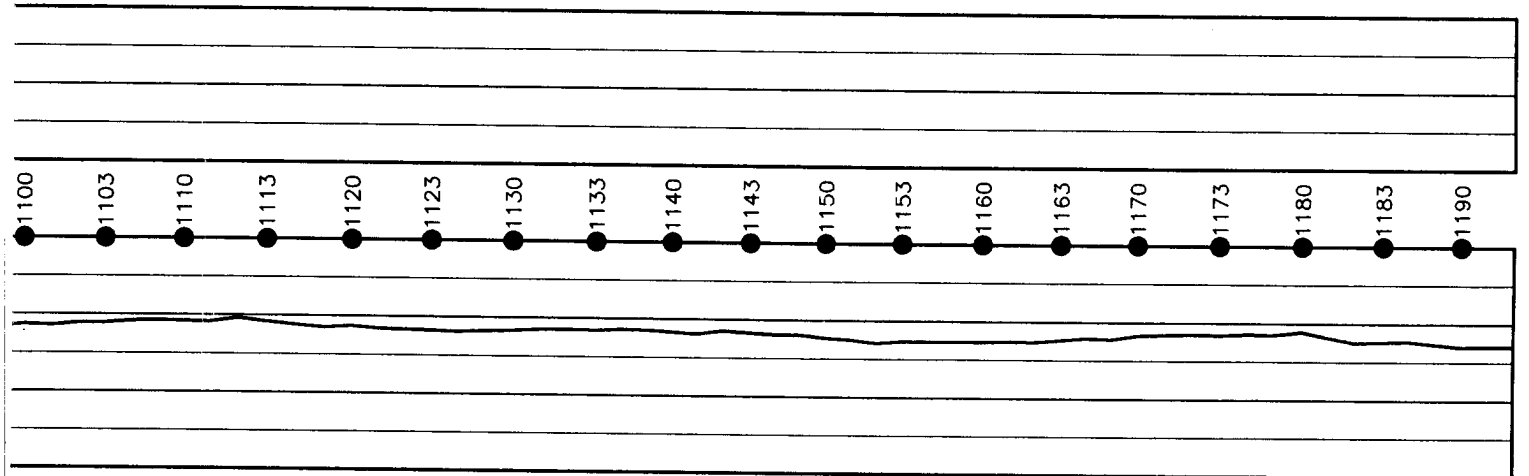
LINE # PP1A (cont)

Vertical Exaggeration X 2

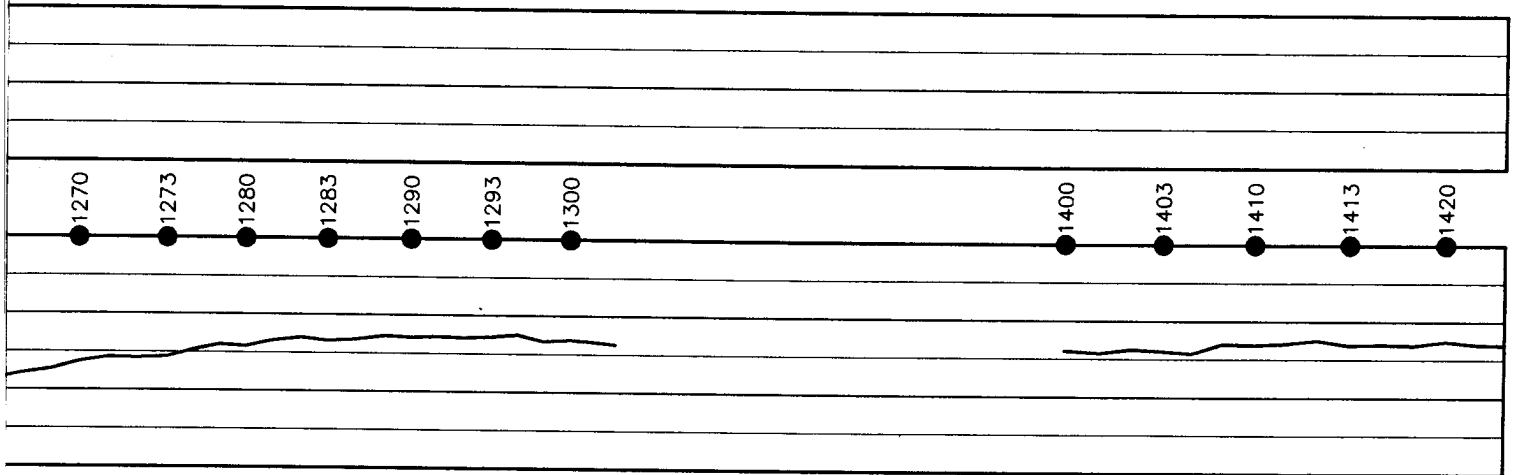


PROJECT AREA: POOL 3 NAVIGATION CHANNEL, MONONGAHELA RIVER, PA.

2



LINE # PP1A (cont)



LINE # PP1A (cont)

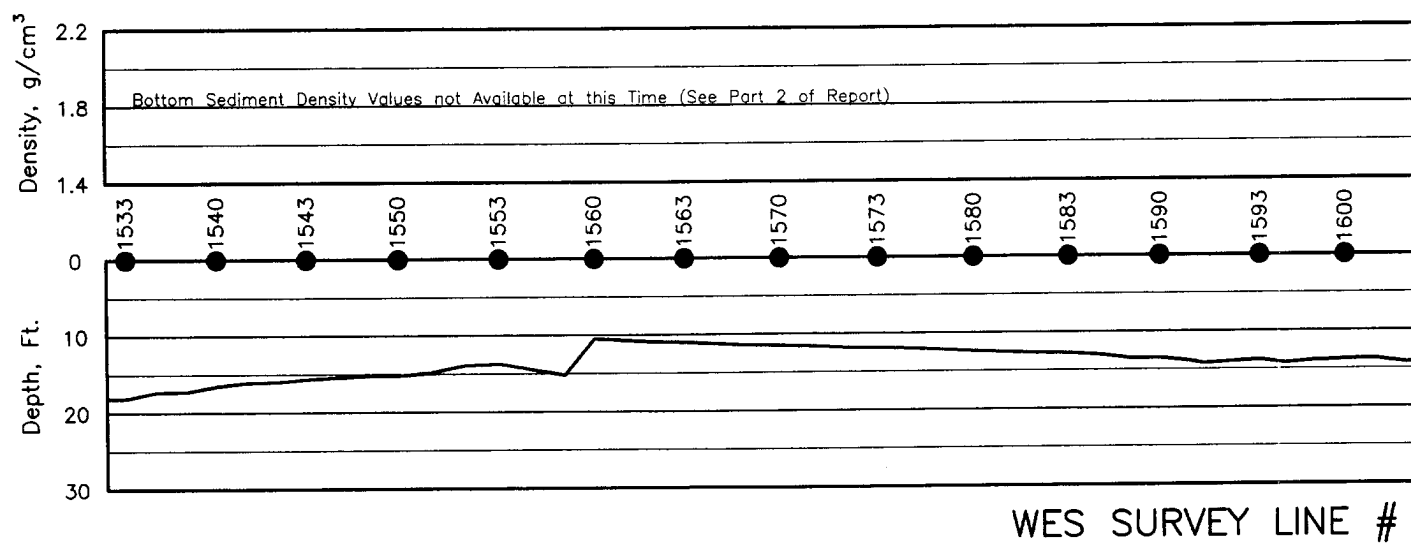
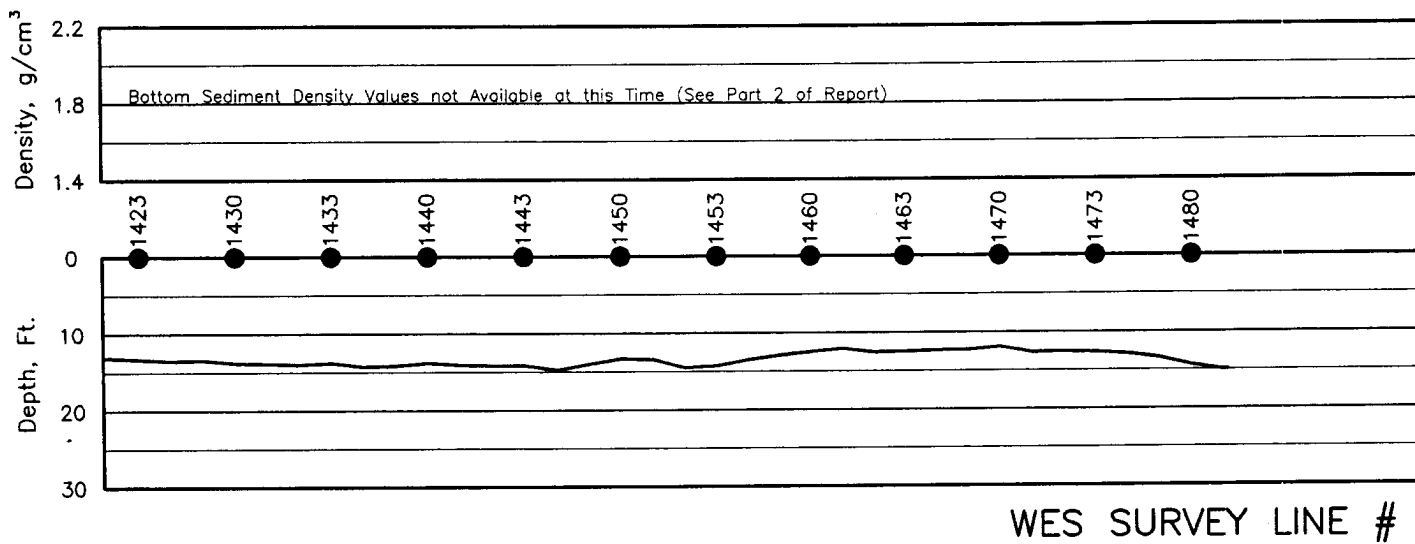
Vertical Exaggeration X 2

ER, PA.

PLATE F4

SCALE: 1"=500'

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PROJECT AREA: POOL 3 NAVIGATION CHANNEL, MONONGAHELA RIVER, PA

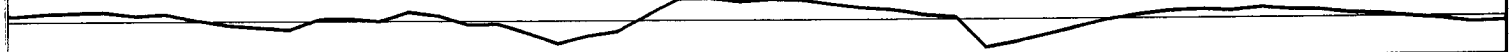
2

1490 1493 1500 1503 1510 1513 1520 1523 1530



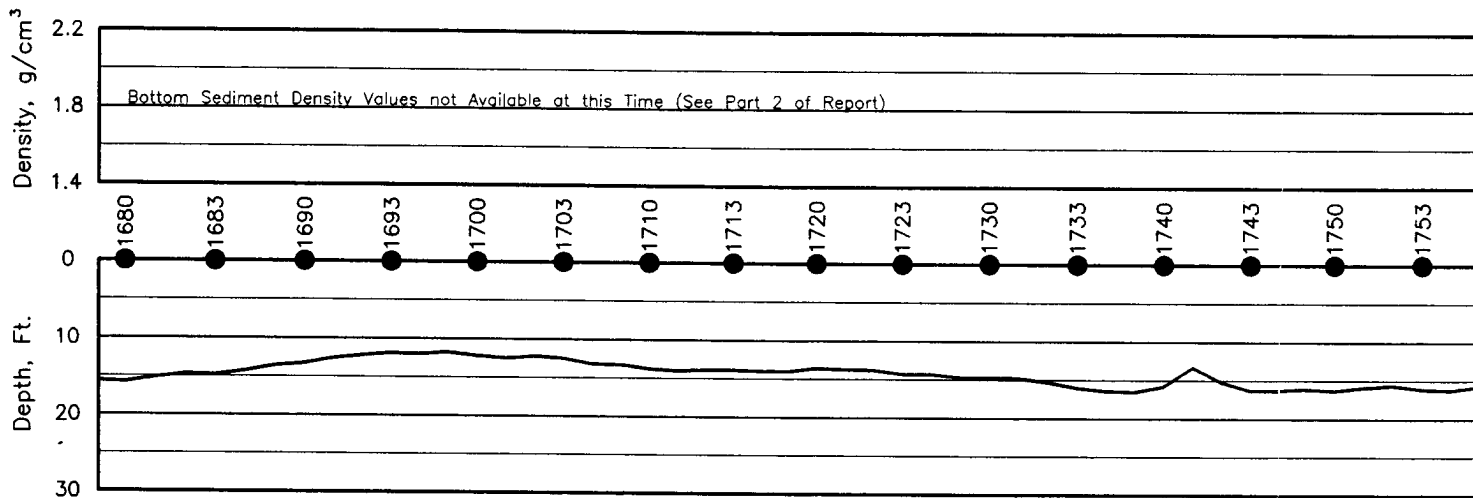
LINE # PP1A (cont)

1600 1603 1610 1613 1620 1623 1630 1633 1640 1643 1650 1653 1660 1663 1670 1673

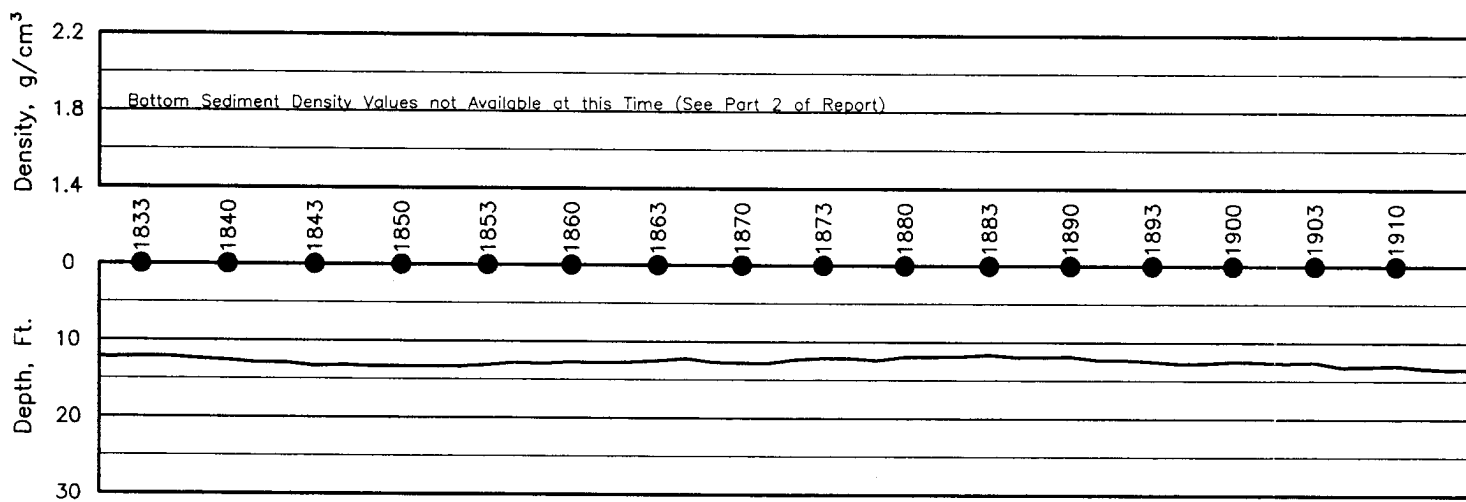


LINE # PP1A (cont)

Vertical Exaggeration X 2



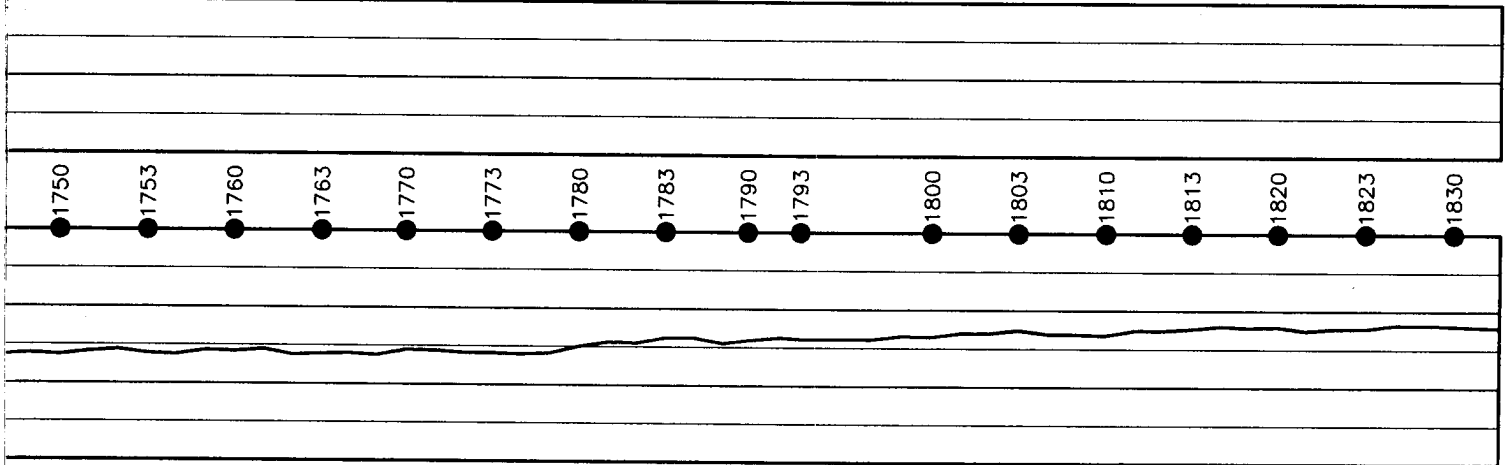
WES SURVEY LINE # PP



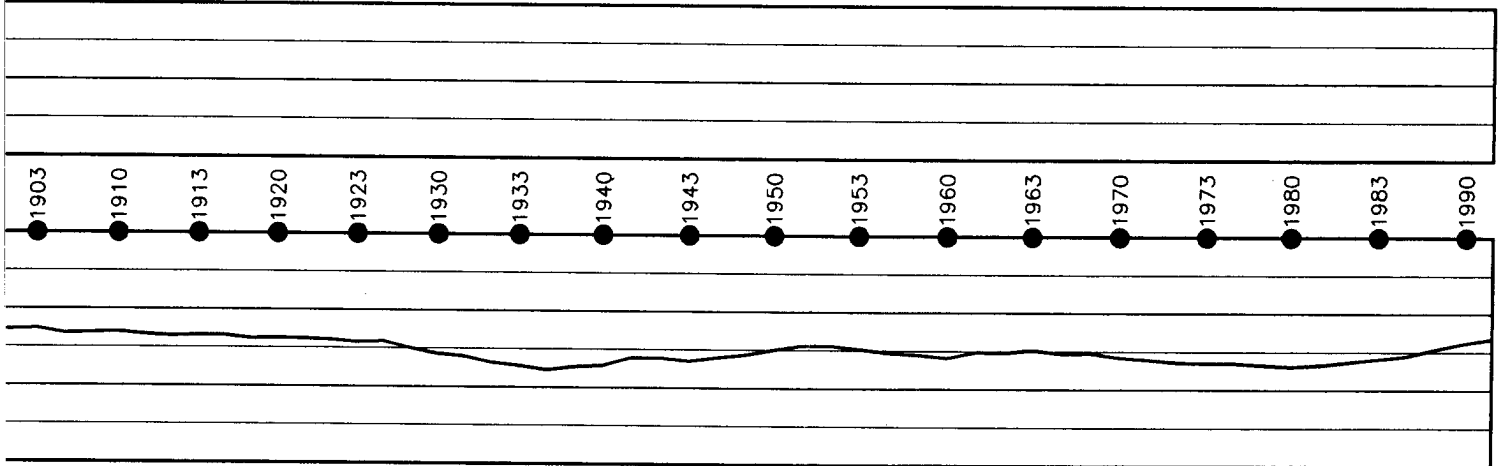
WES SURVEY LINE # PP

PROJECT AREA: POOL 3 NAVIGATION CHANNEL, MONONGAHELA RIVER, PA.

2

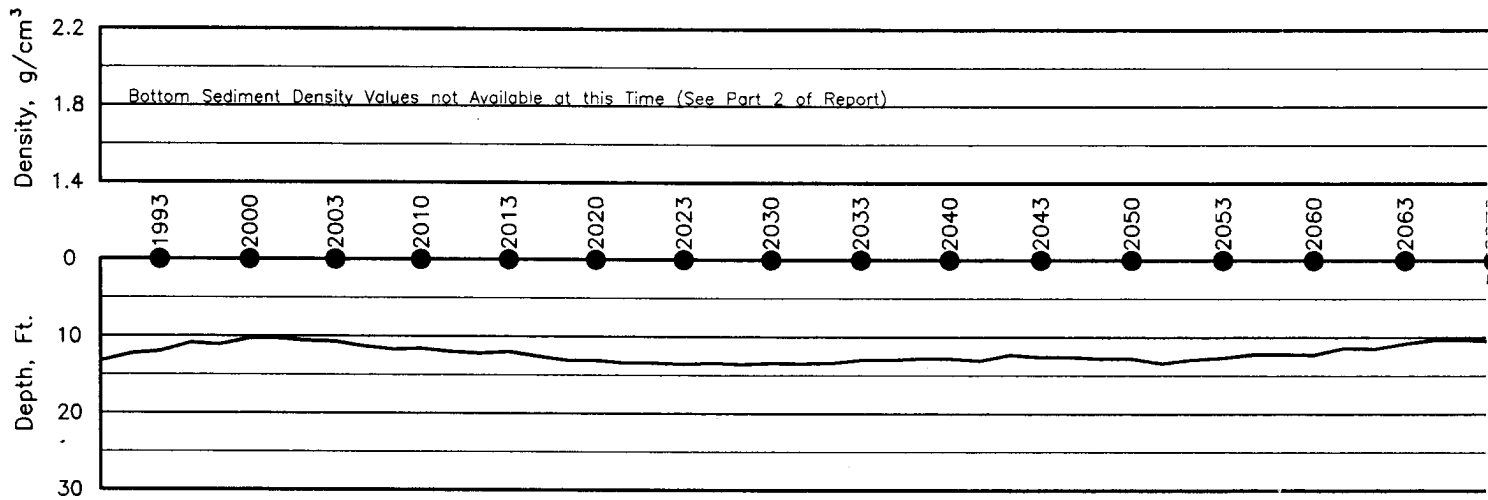


LINE # PP1A (cont)

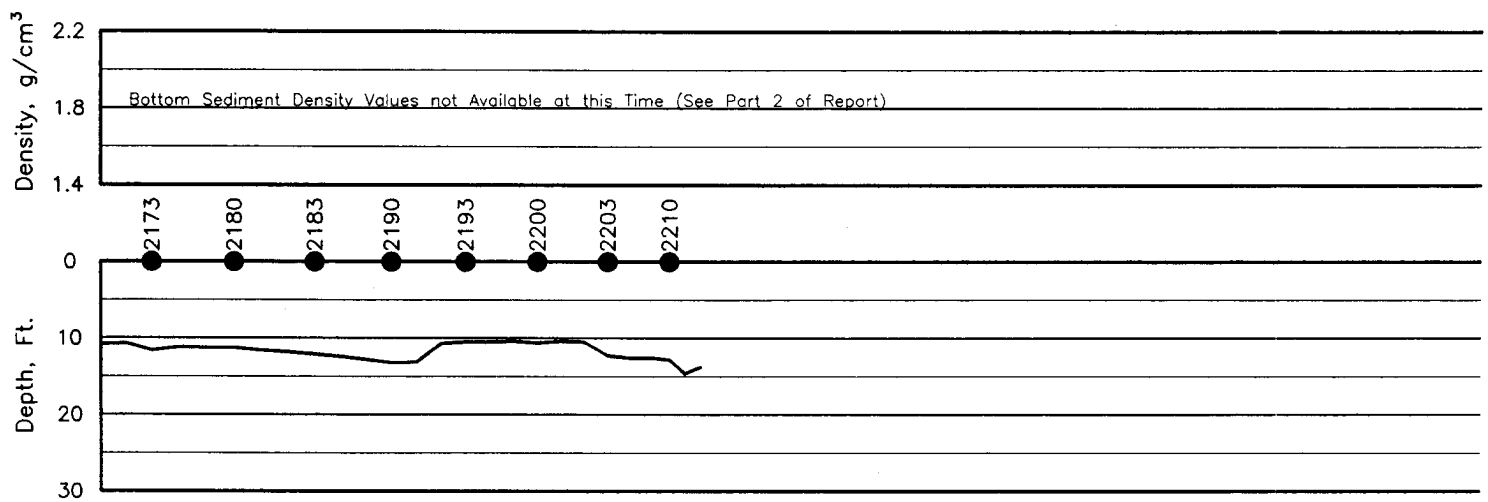


LINE # PP1A (cont)

Vertical Exaggeration X 2



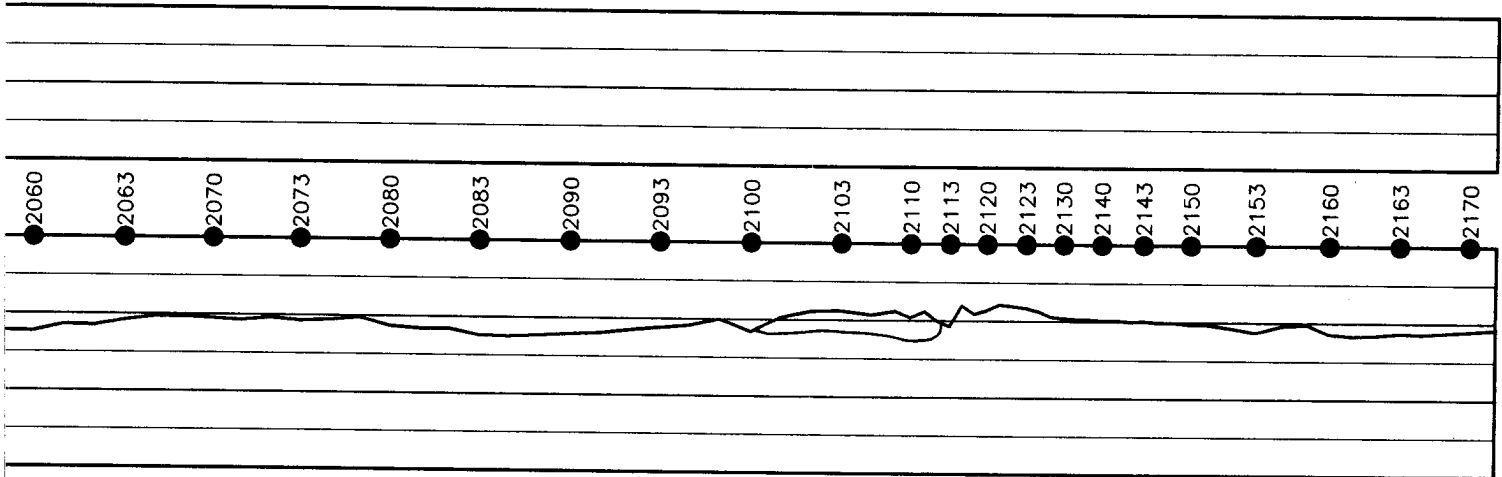
WES SURVEY LINE # PP1



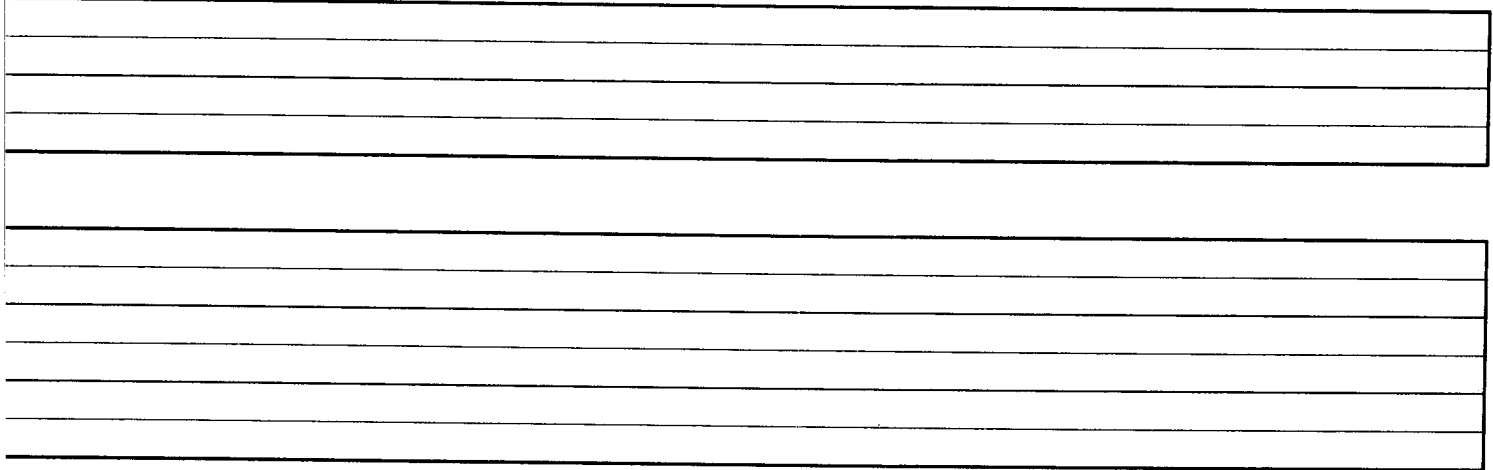
WES SURVEY LINE # PP1

PROJECT AREA: POOL 3 NAVIGATION CHANNEL, MONONGAHELA RIVER, PA.

2



INE # PP1A (cont)



NE # PP1A (cont)

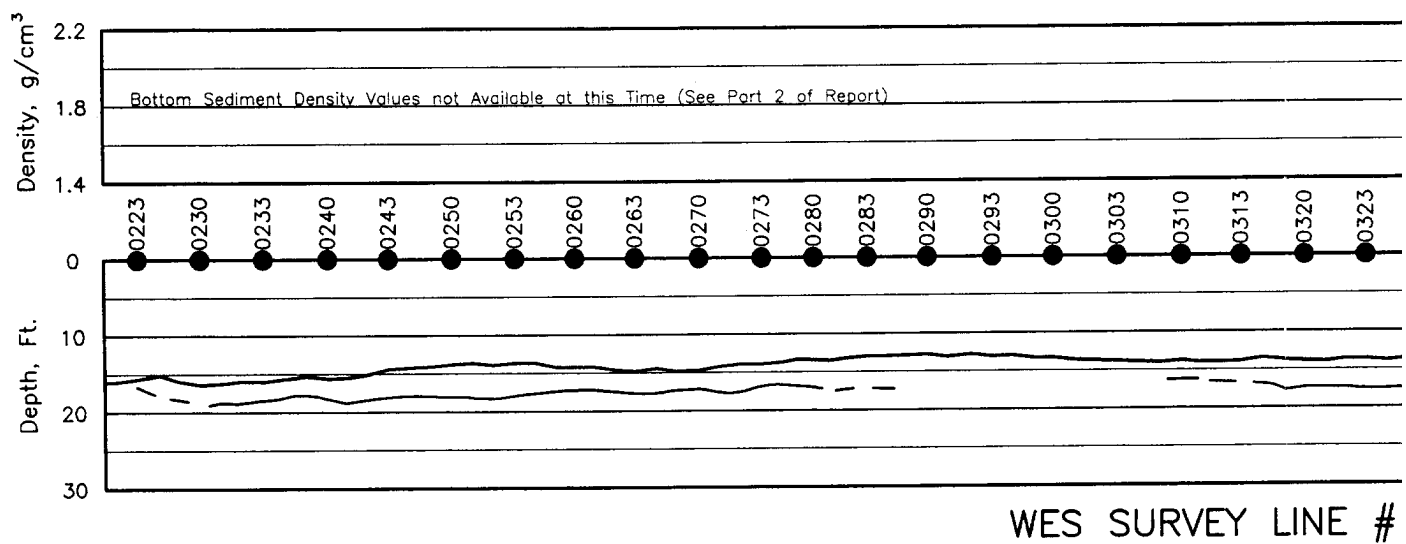
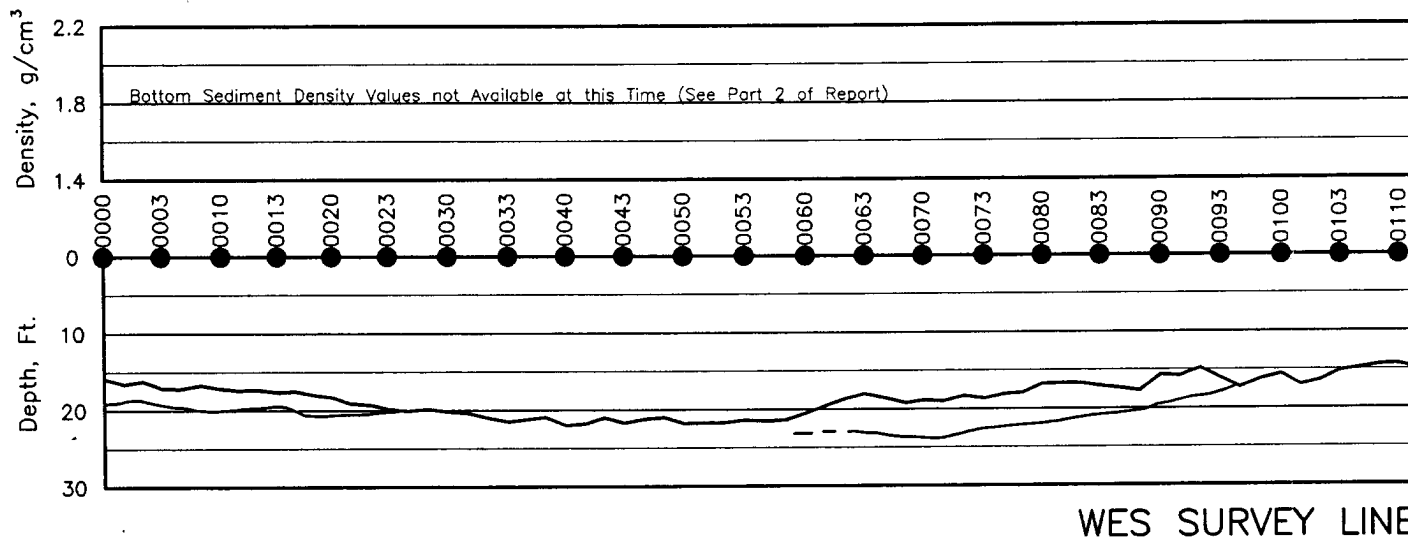
Vertical Exaggeration X 2

R, PA.

PLATE F7

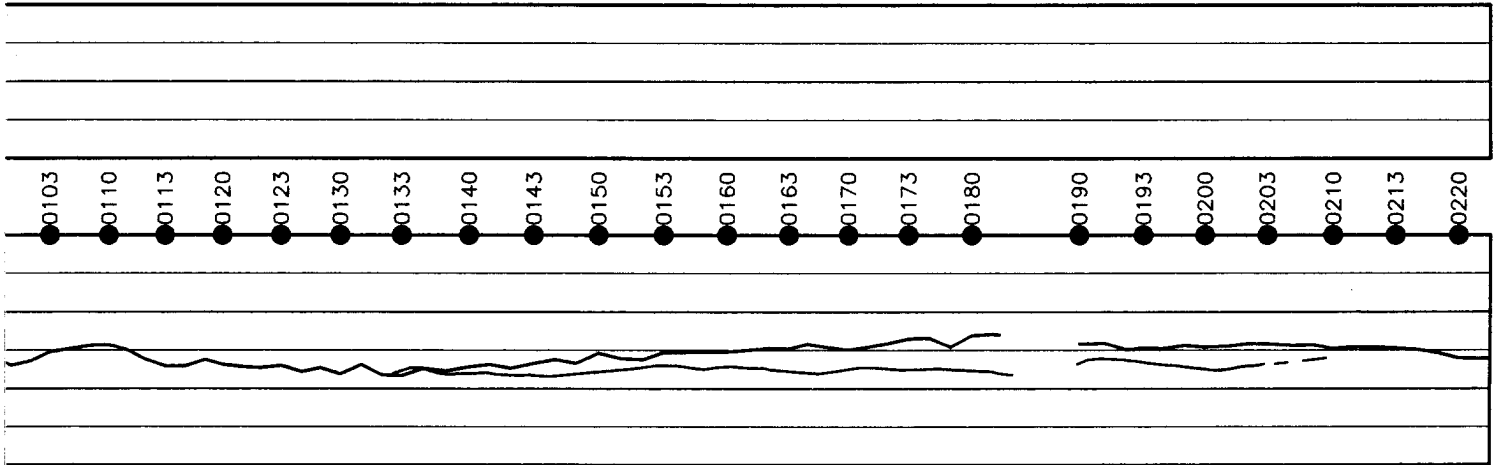
SCALE: 1"=500'

13 MARCH 1996

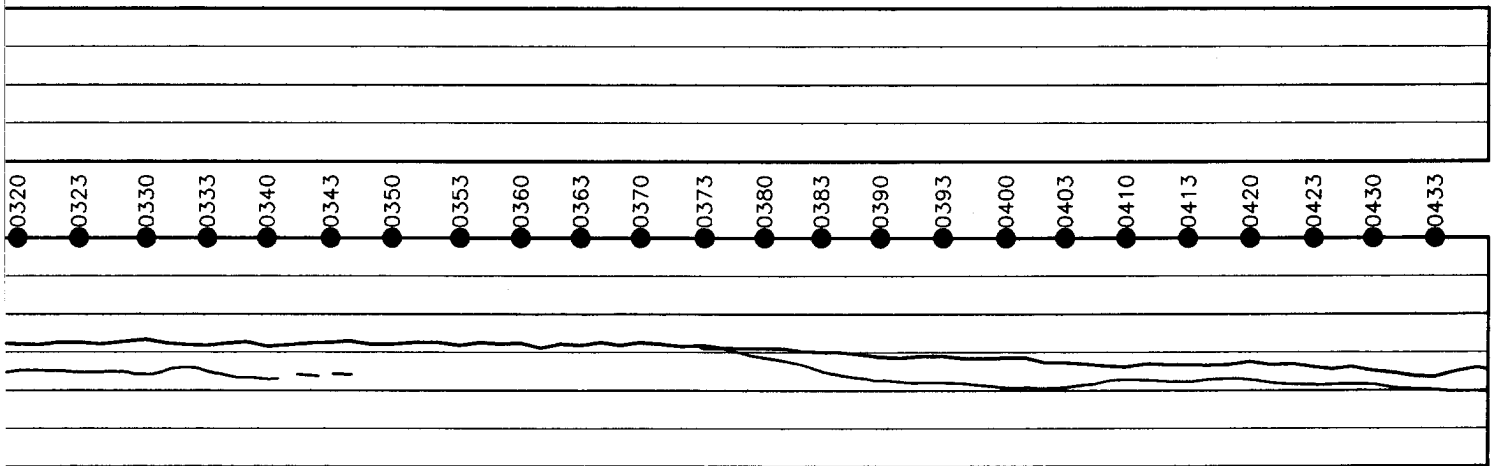


PROJECT AREA: POOL 3 NAVIGATION CHANNEL, MONONGAHELA RIVER, PA

2

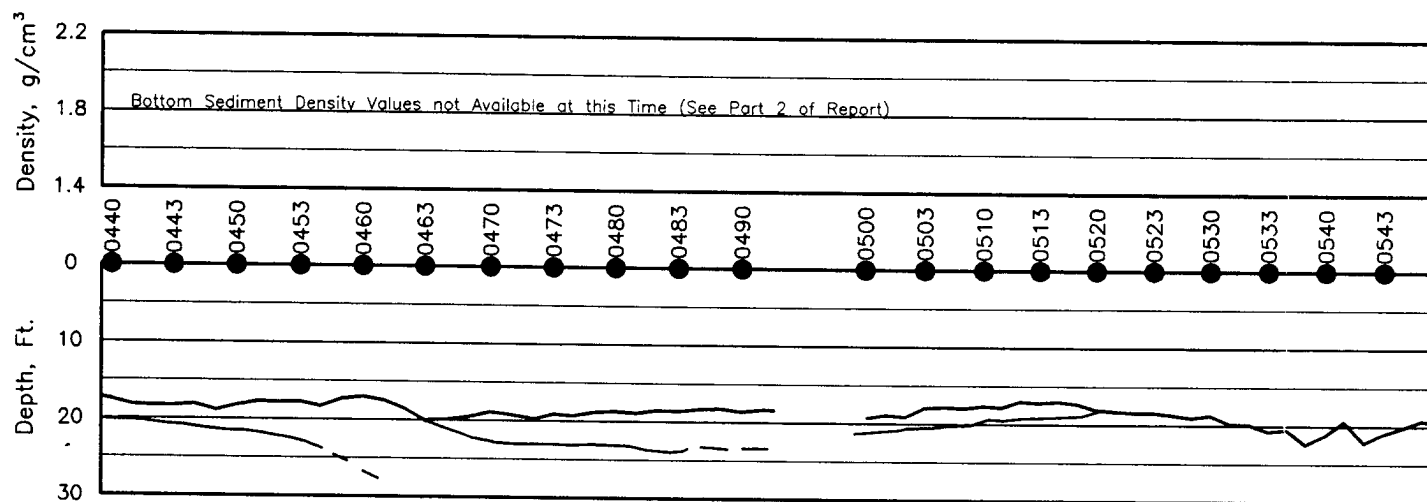


Y LINE # PP2A

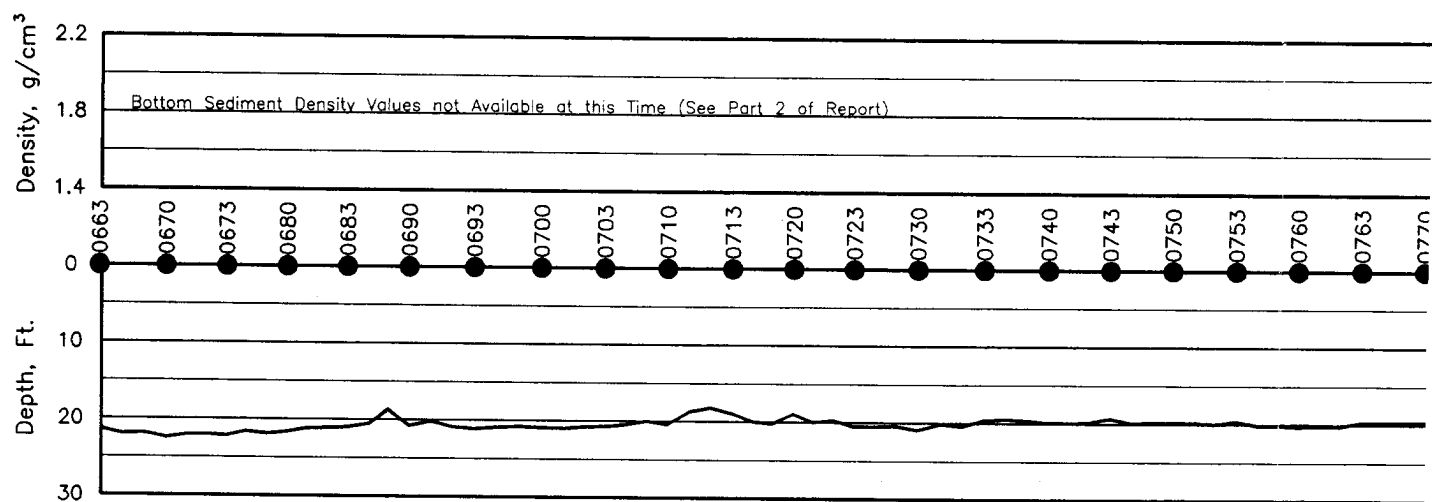


Y LINE # PP2A (cont)

Vertical Exaggeration X 2



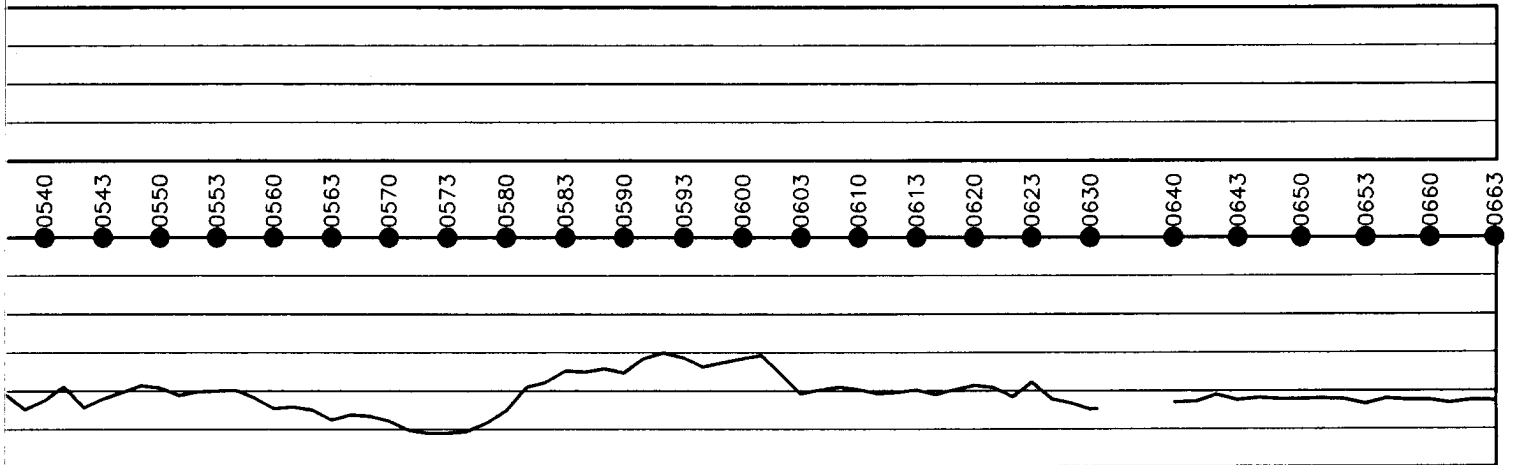
WES SURVEY LINE # F



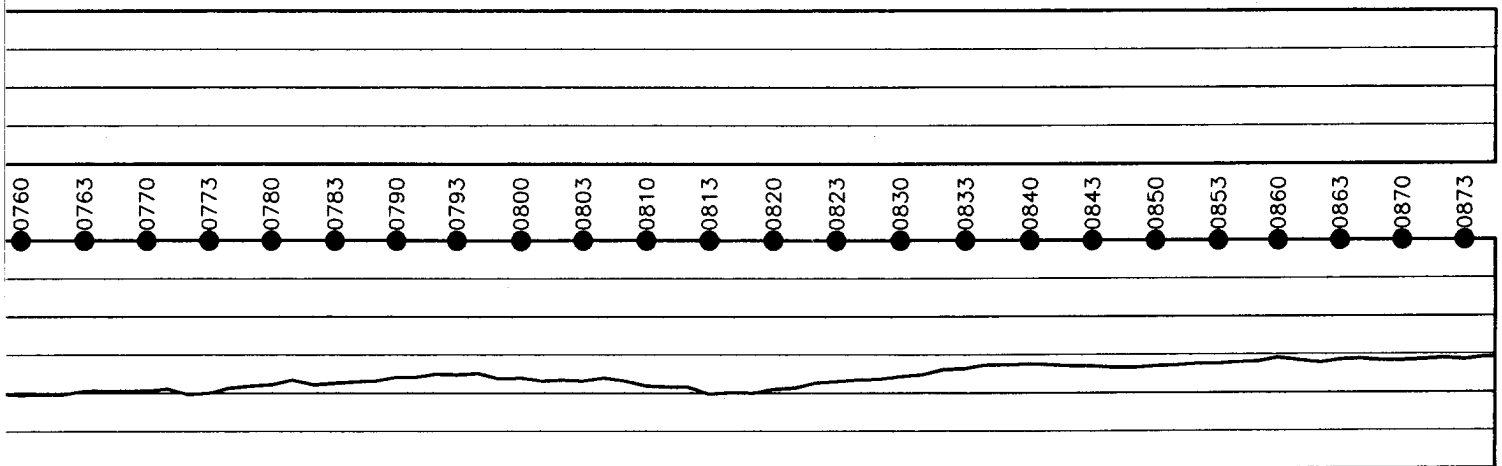
WES SURVEY LINE # I

PROJECT AREA: POOL 3 NAVIGATION CHANNEL, MONONGAHELA RIVER, PA.

2

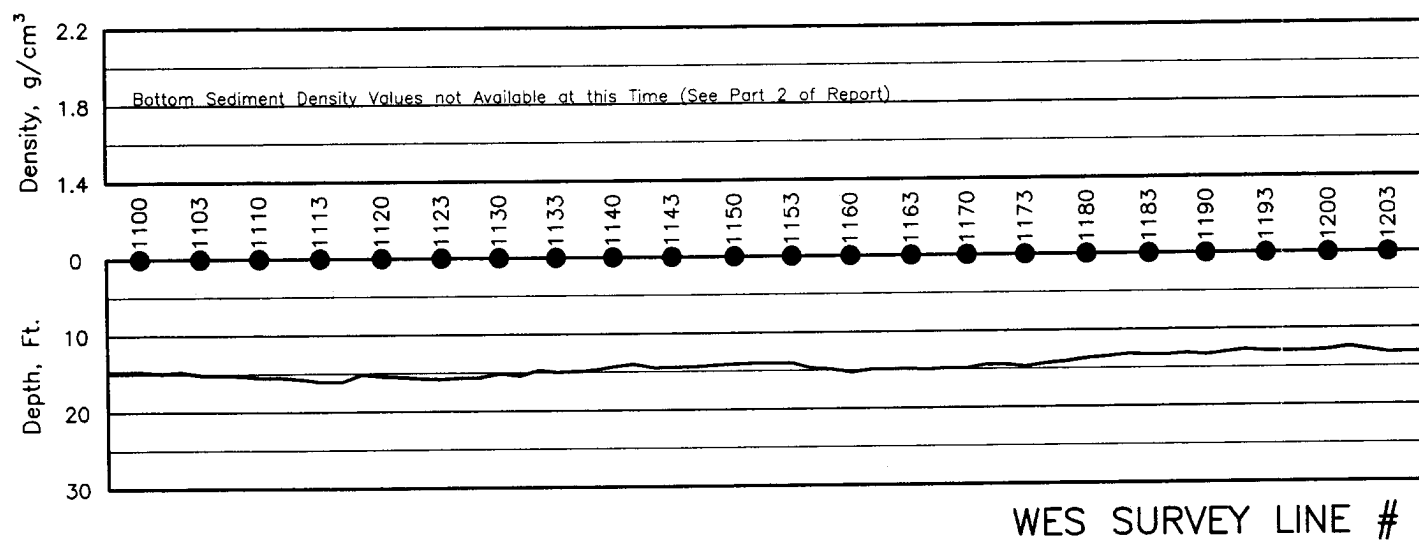
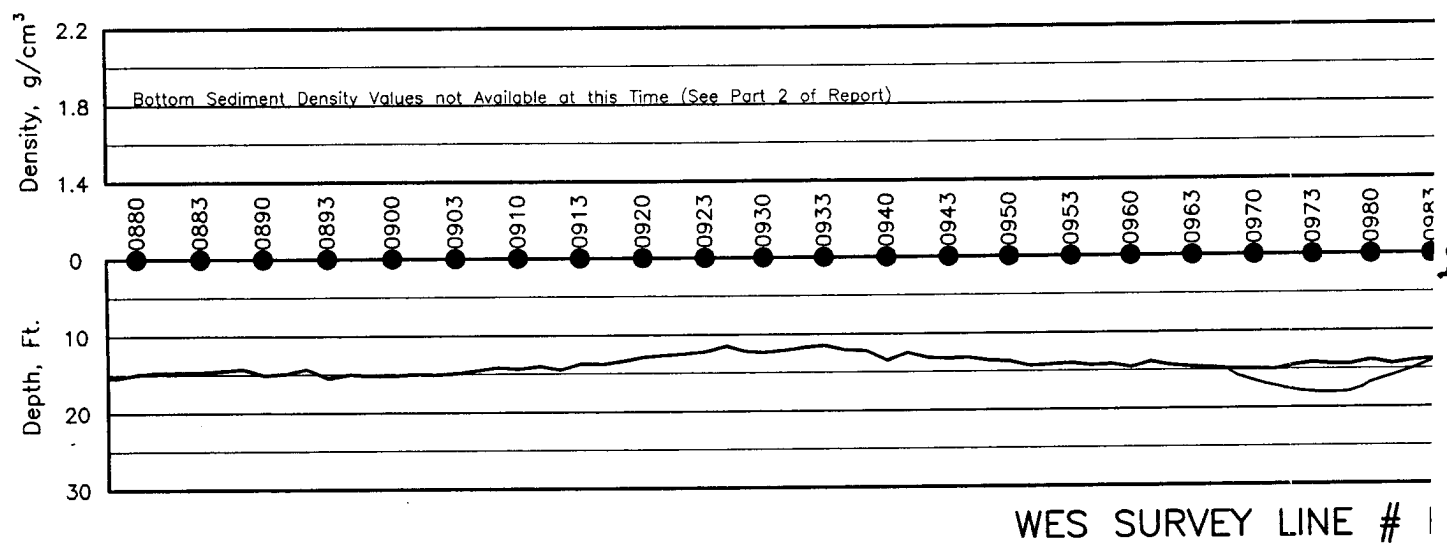


LINE # PP2A (cont)



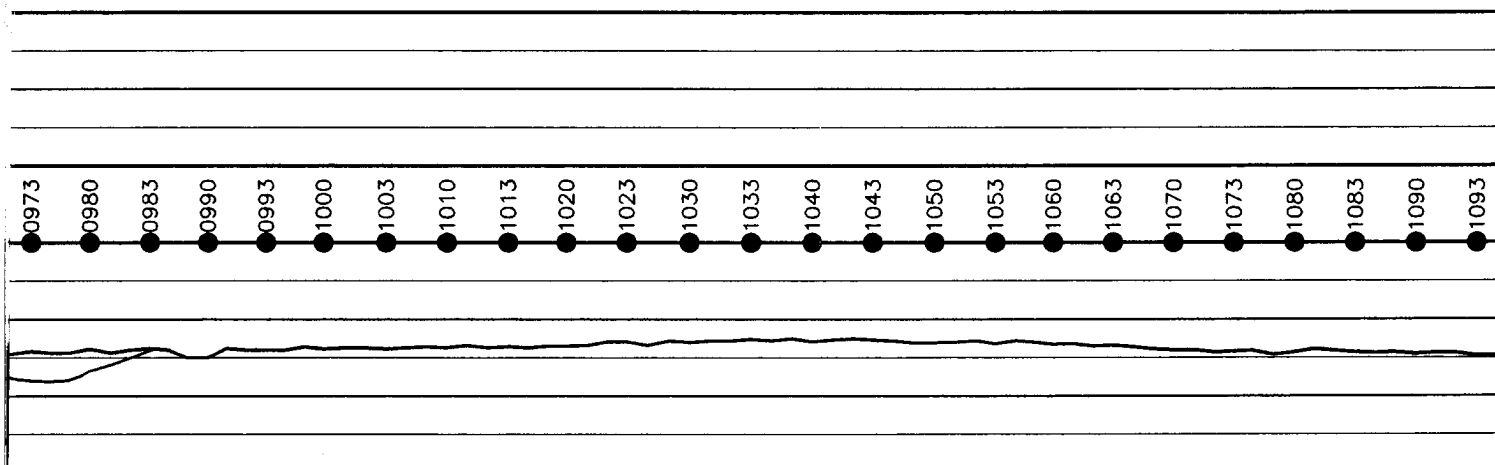
LINE # PP2A (cont)

Vertical Exaggeration X 2

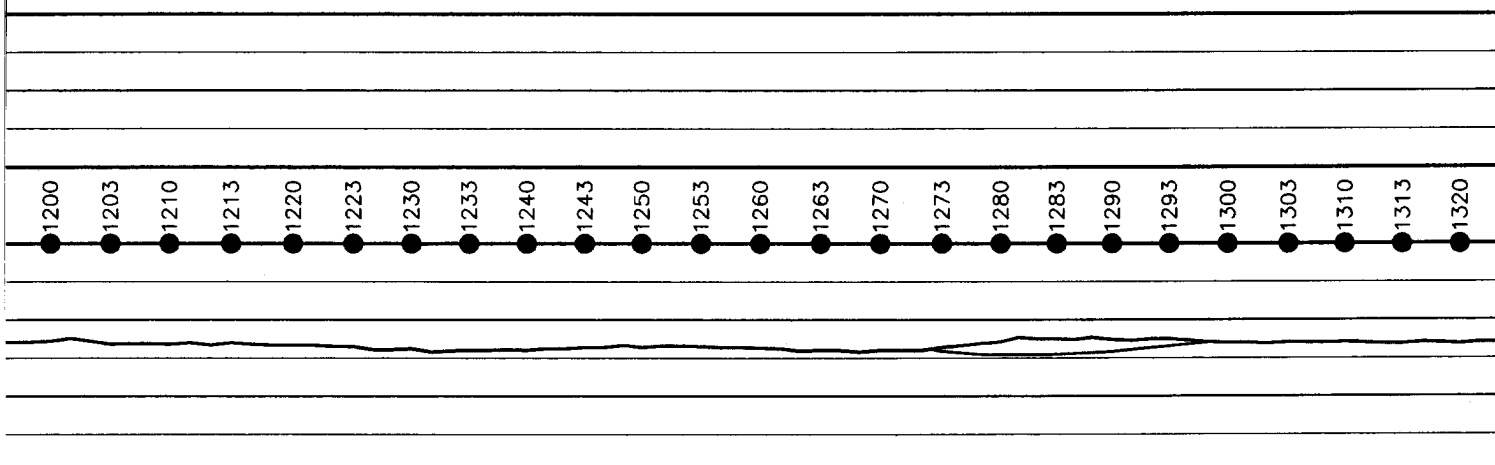


PROJECT AREA: POOL 3 NAVIGATION CHANNEL, MONONGAHELA RIVER, PA

2

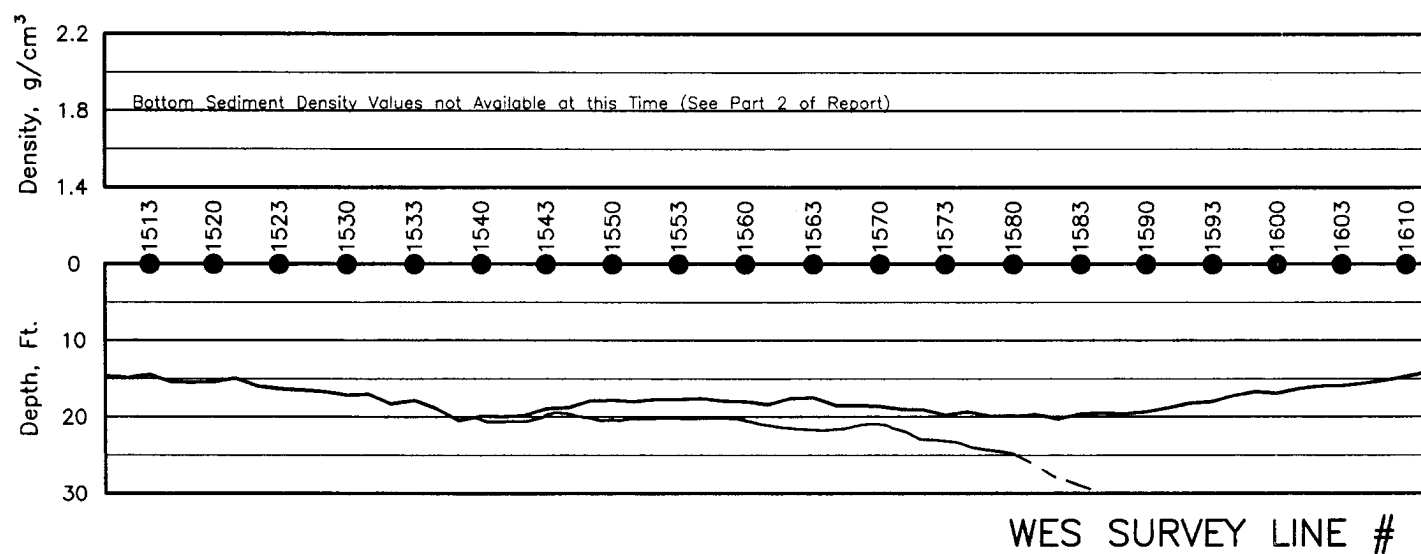
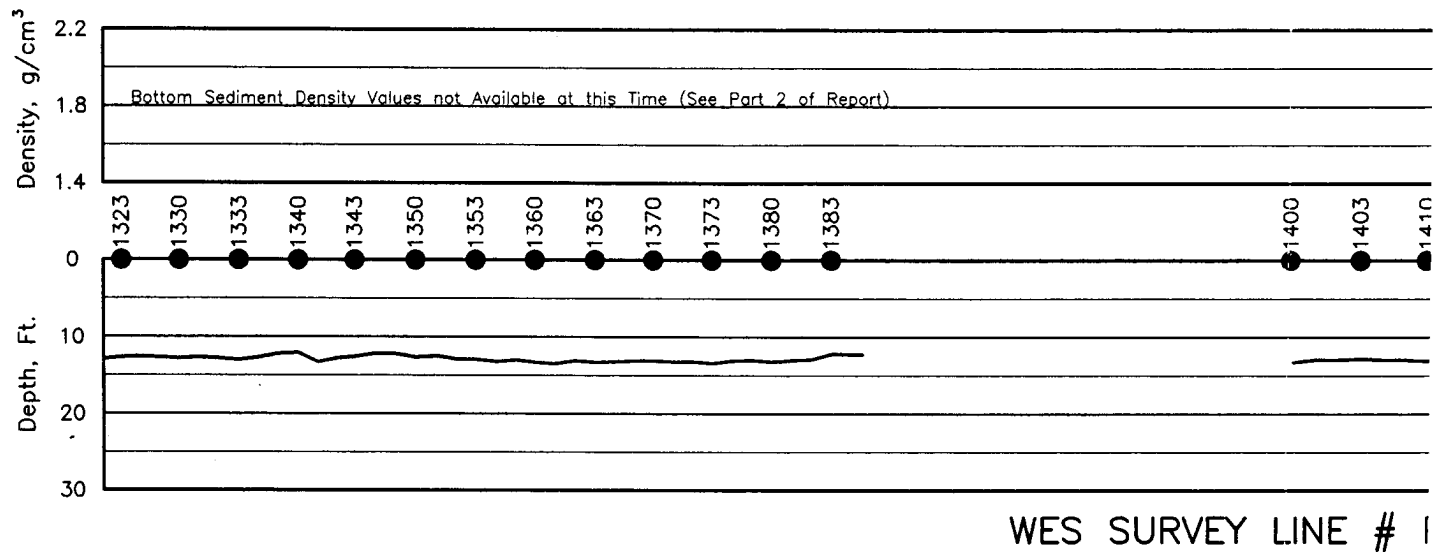


LINE # PP2A (cont)



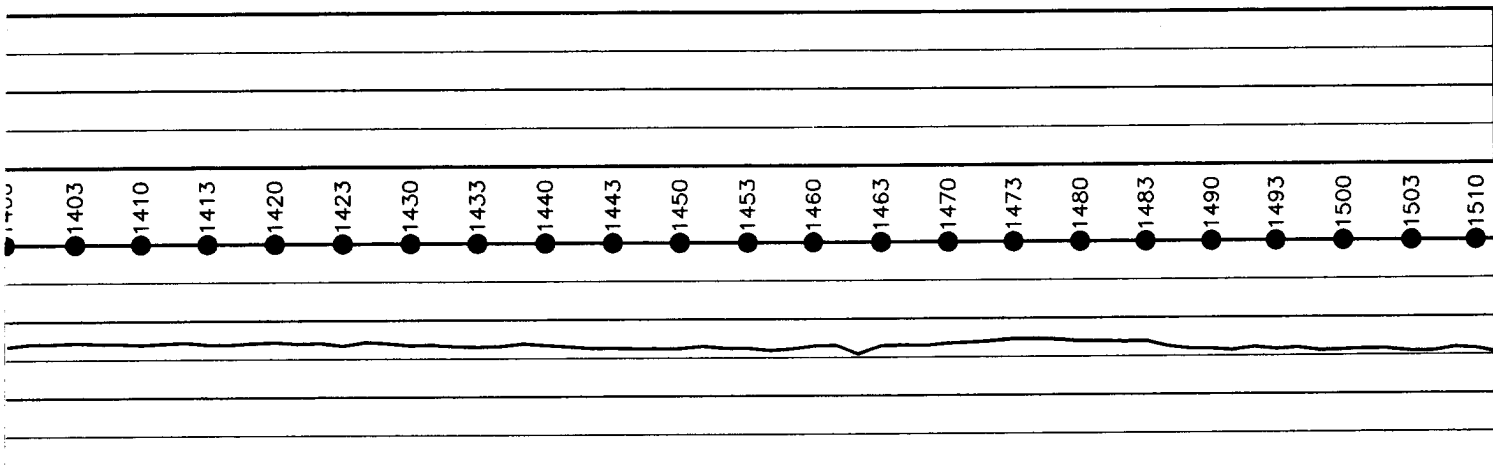
LINE # PP2A (cont)

Vertical Exaggeration X 2

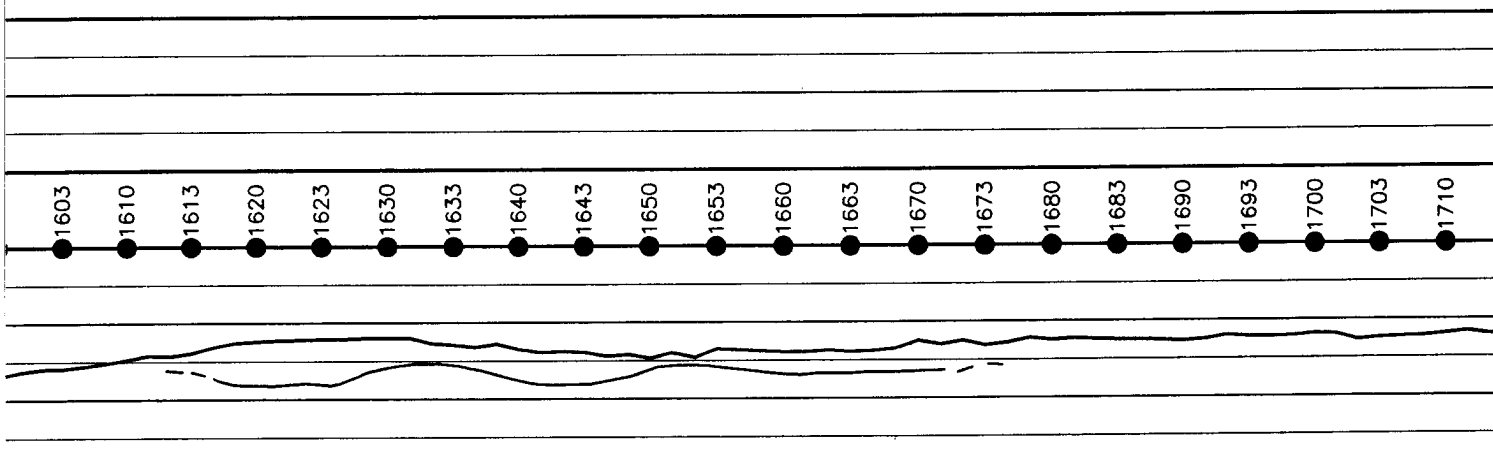


PROJECT AREA: POOL 3 NAVIGATION CHANNEL, MONONGAHELA RIVER, PA.

2

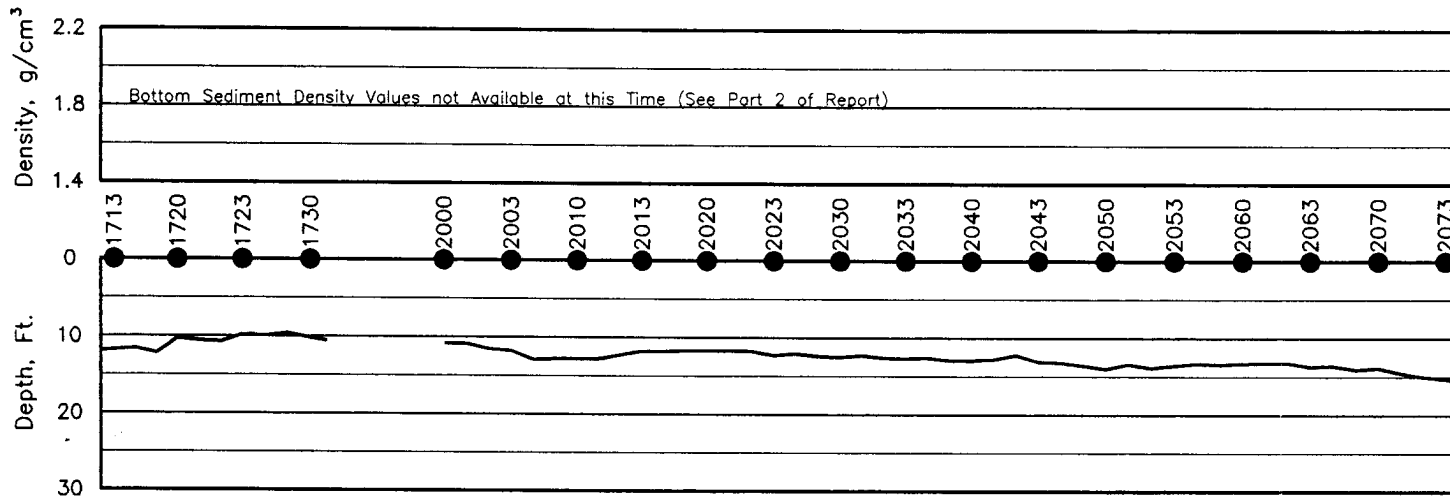


LINE # PP2A (cont)

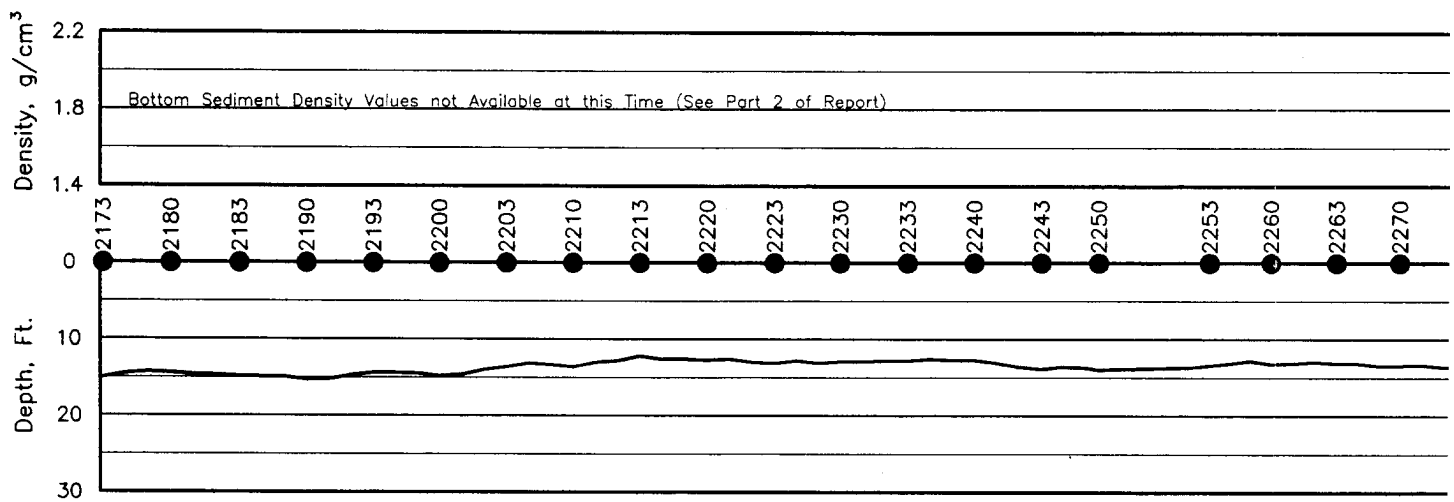


LINE # PP2A (cont)

Vertical Exaggeration X 2



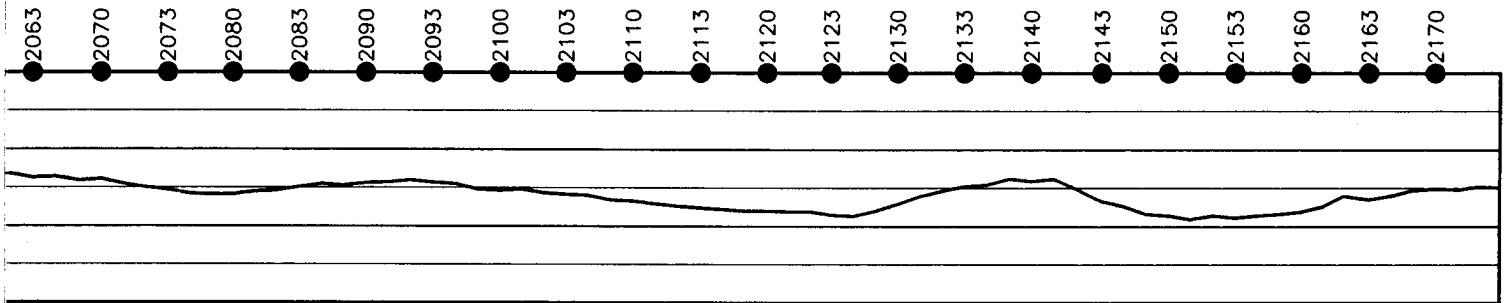
WES SURVEY LINE # PI



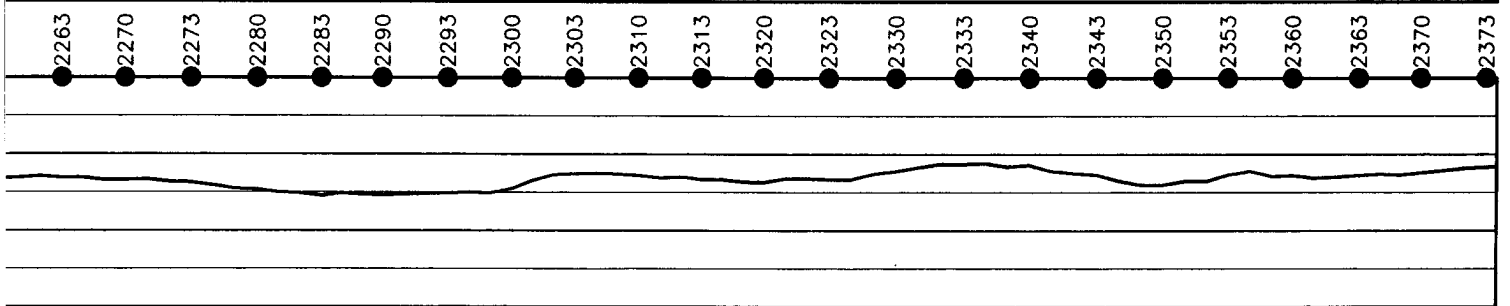
WES SURVEY LINE # PI

PROJECT AREA: POOL 3 NAVIGATION CHANNEL, MONONGAHELA RIVER, PA.

2

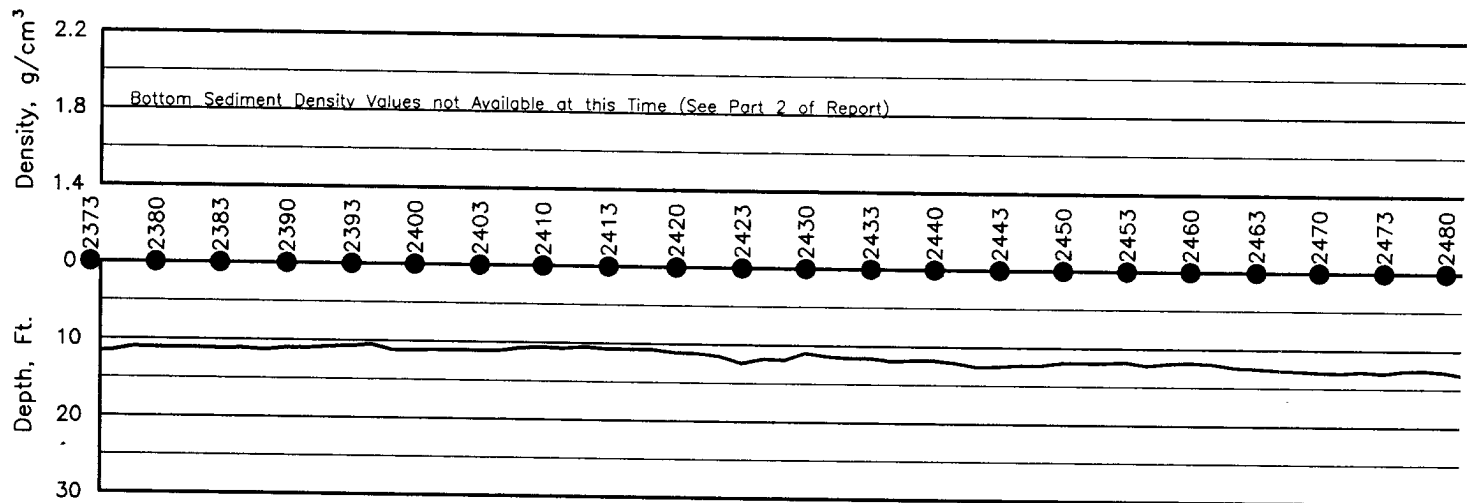


LINE # PP2A (cont)

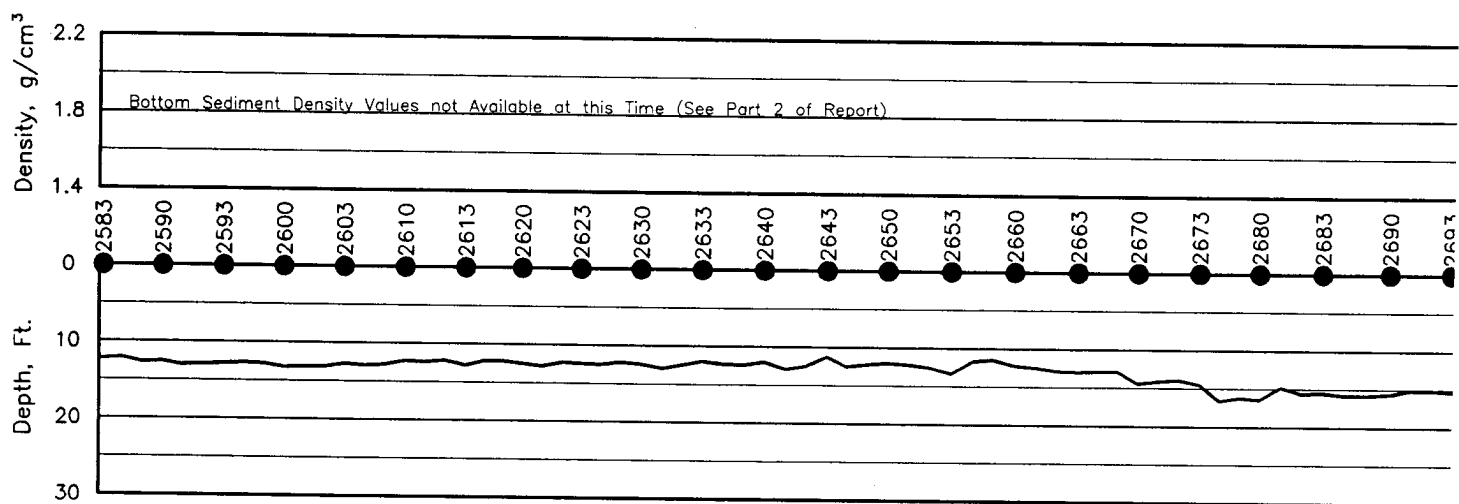


LINE # PP2A (cont)

Vertical Exaggeration X 2



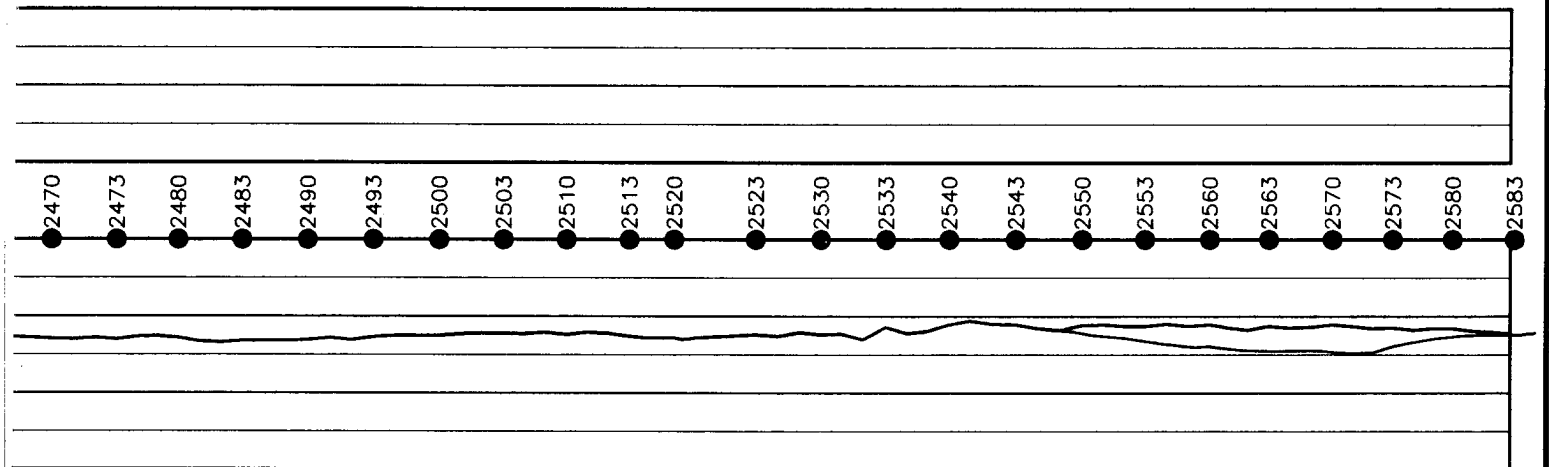
WES SURVEY LINE # PF



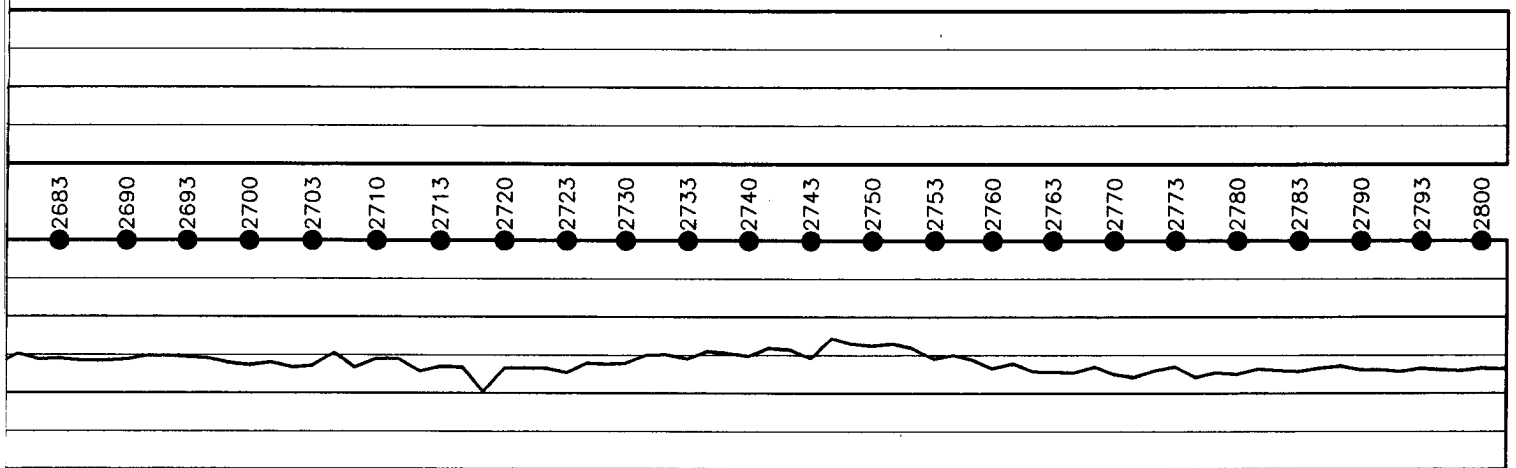
WES SURVEY LINE # PF

PROJECT AREA: POOL 3 NAVIGATION CHANNEL, MONONGAHELA RIVER, PA.

2

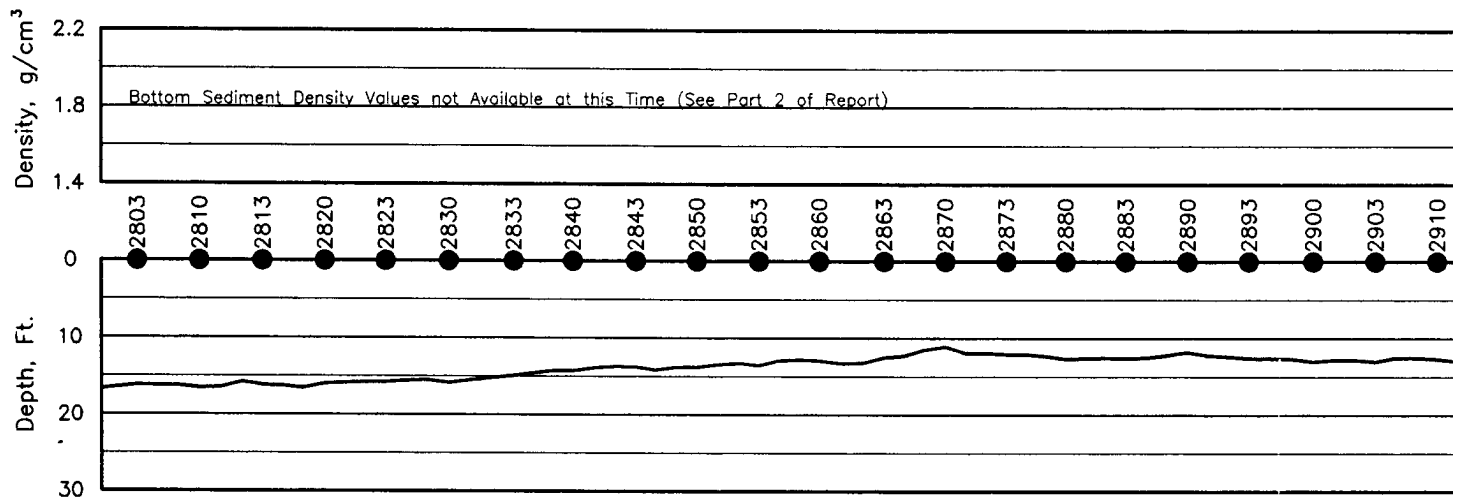


LINE # PP2A (cont)

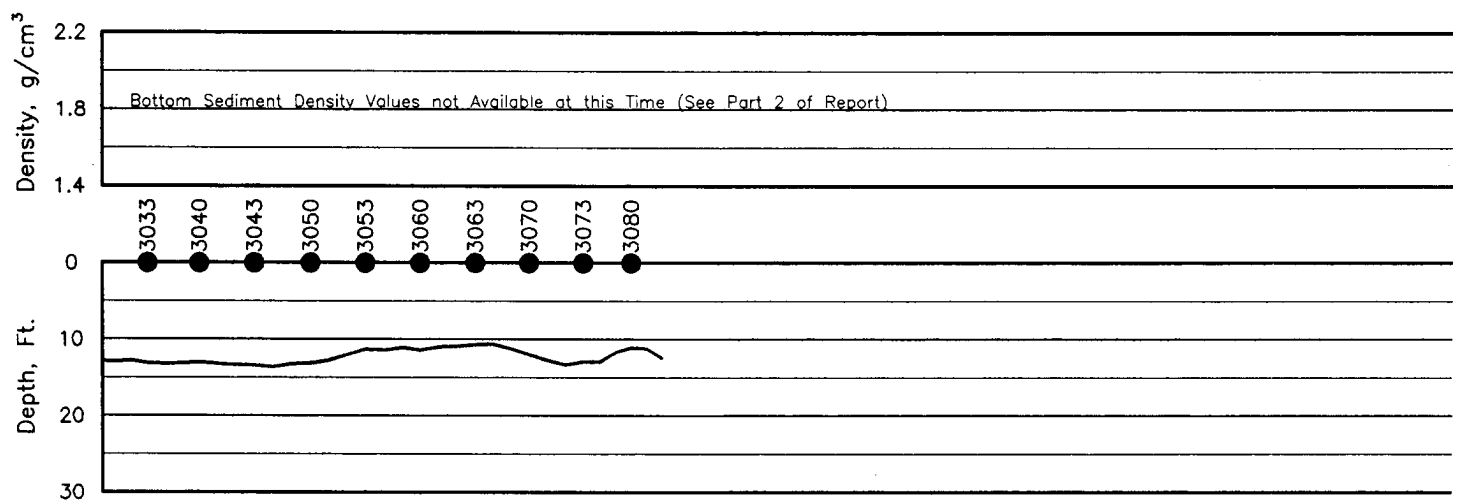


LINE # PP2A (cont)

Vertical Exaggeration X 2



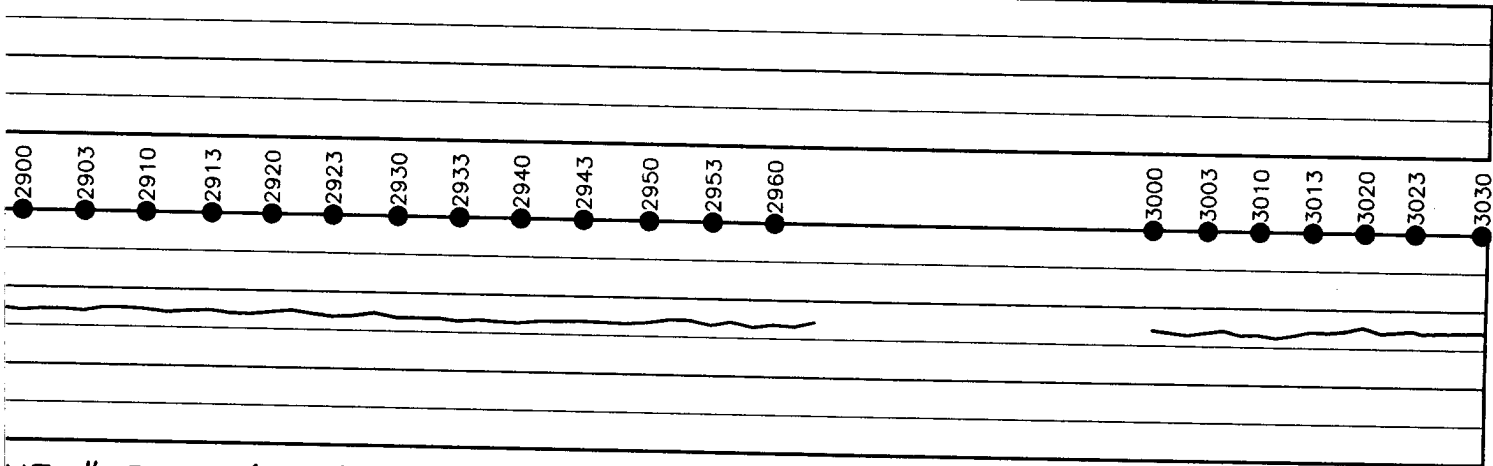
WES SURVEY LINE # 2803-2910



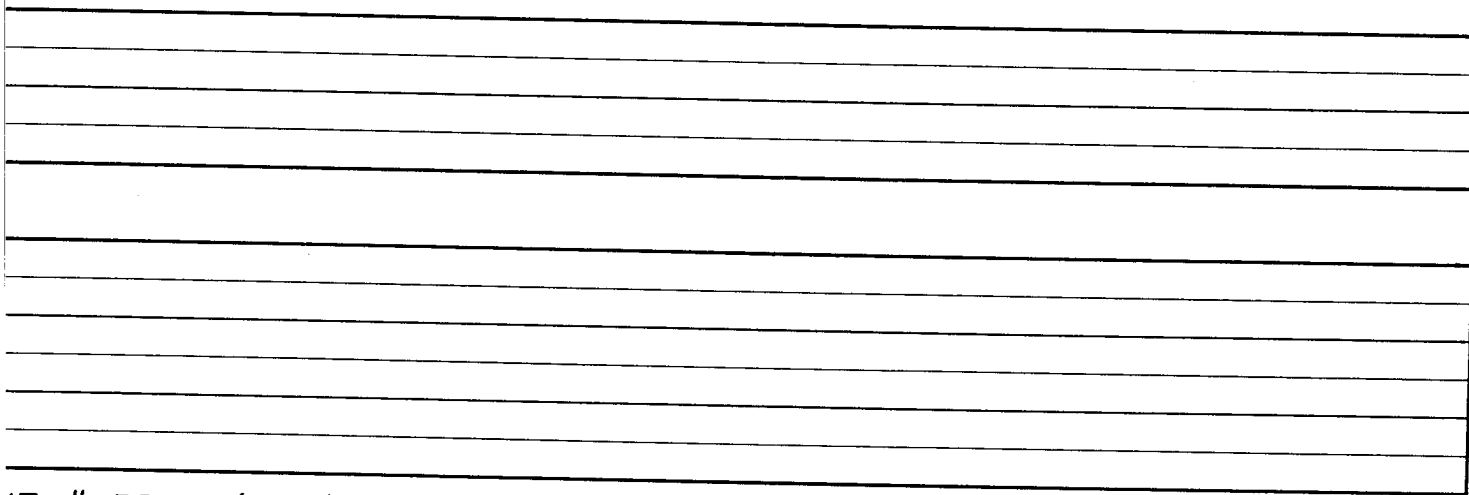
WES SURVEY LINE # 3033-3080

PROJECT AREA: POOL 3 NAVIGATION CHANNEL, MONONGAHELA RIVER, PA.

2



NE # PP2A (cont)



NE # PP2A (cont)

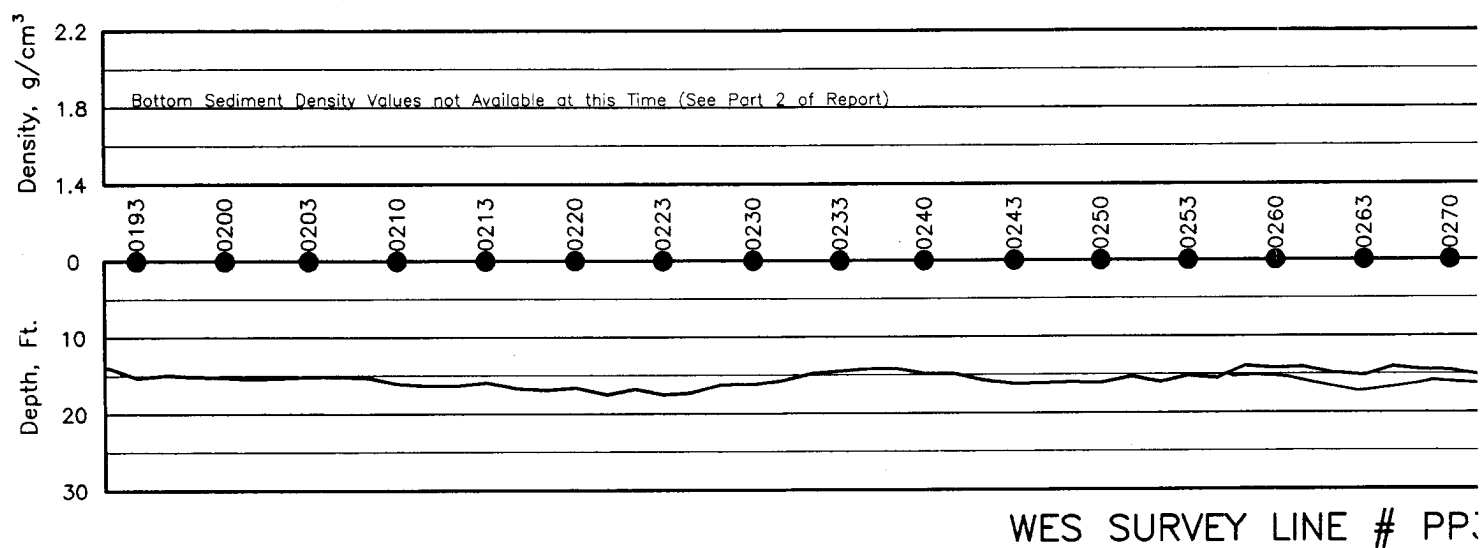
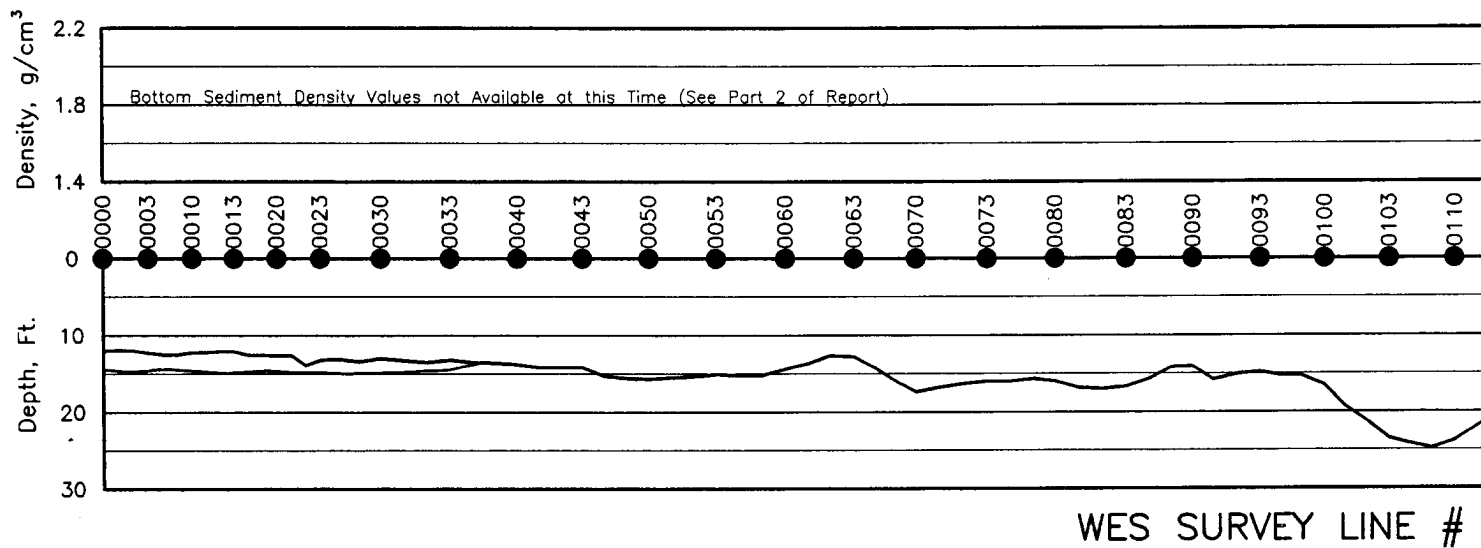
Vertical Exaggeration X 2

R, PA.

PLATE F14

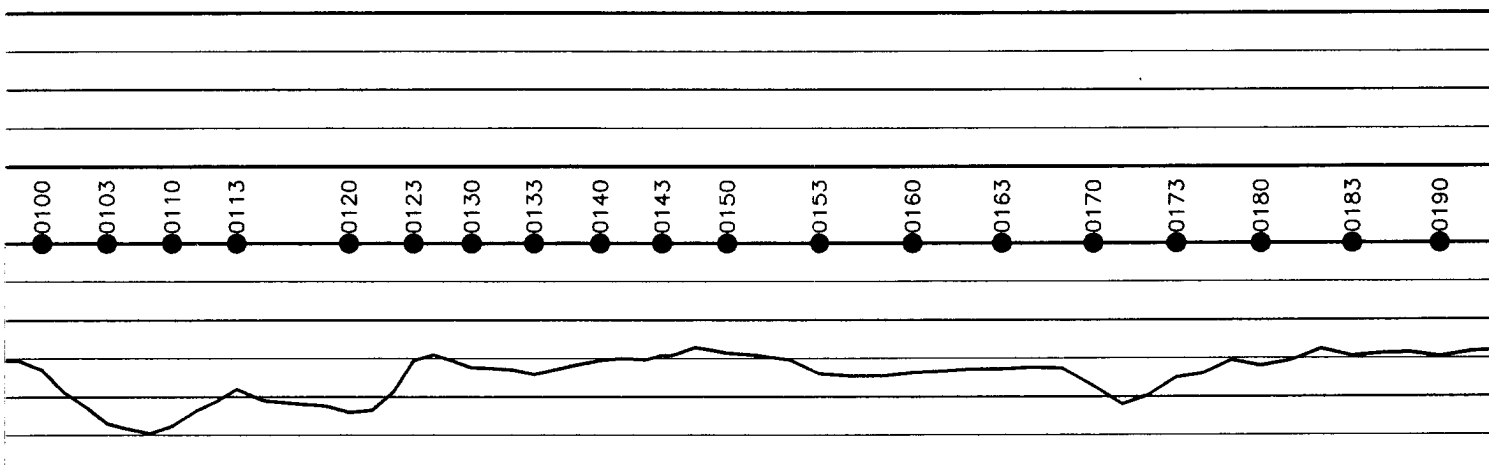
SCALE: 1"=500'

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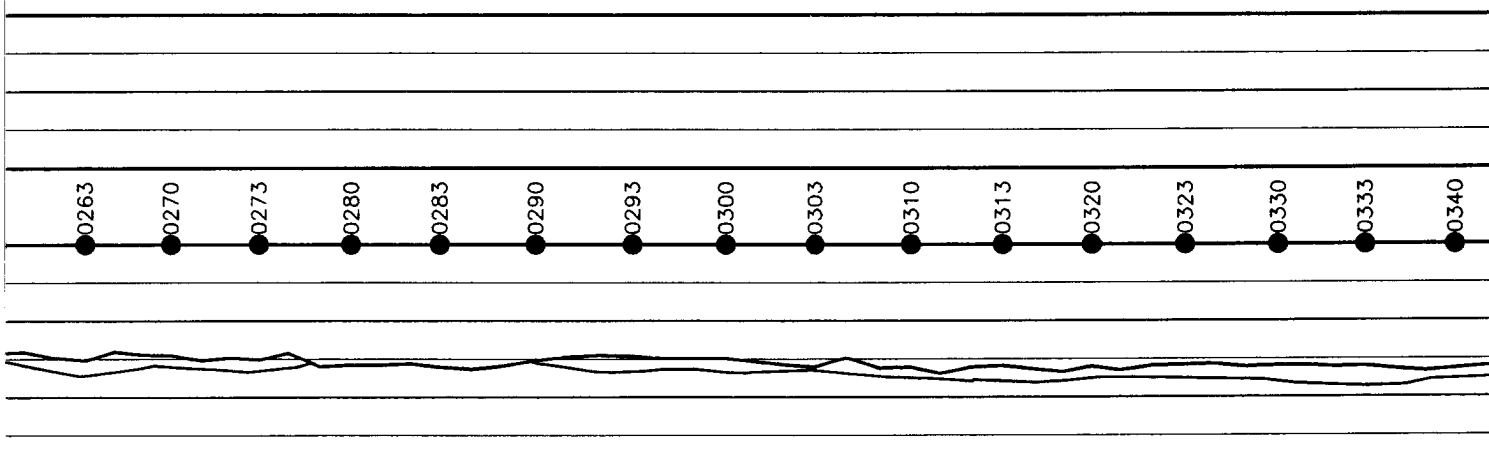


PROJECT AREA: POOL 3 NAVIGATION CHANNEL, MONONGAHELA RIVER, PA.

2

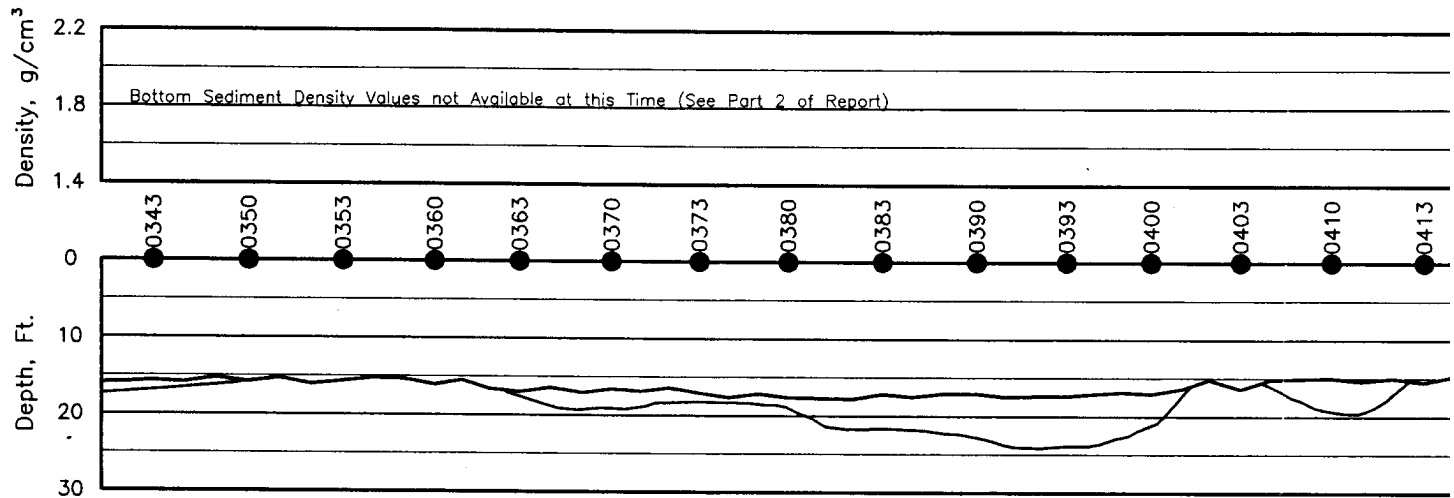


Y LINE # PP3A

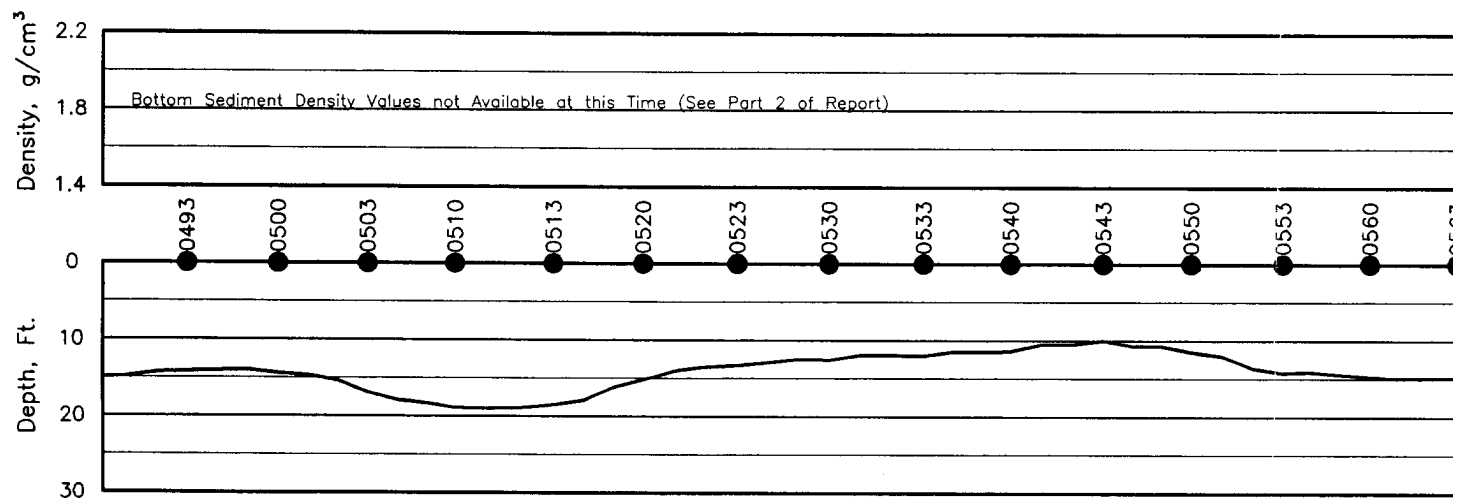


LINE # PP3A (cont)

Vertical Exaggeration X 2



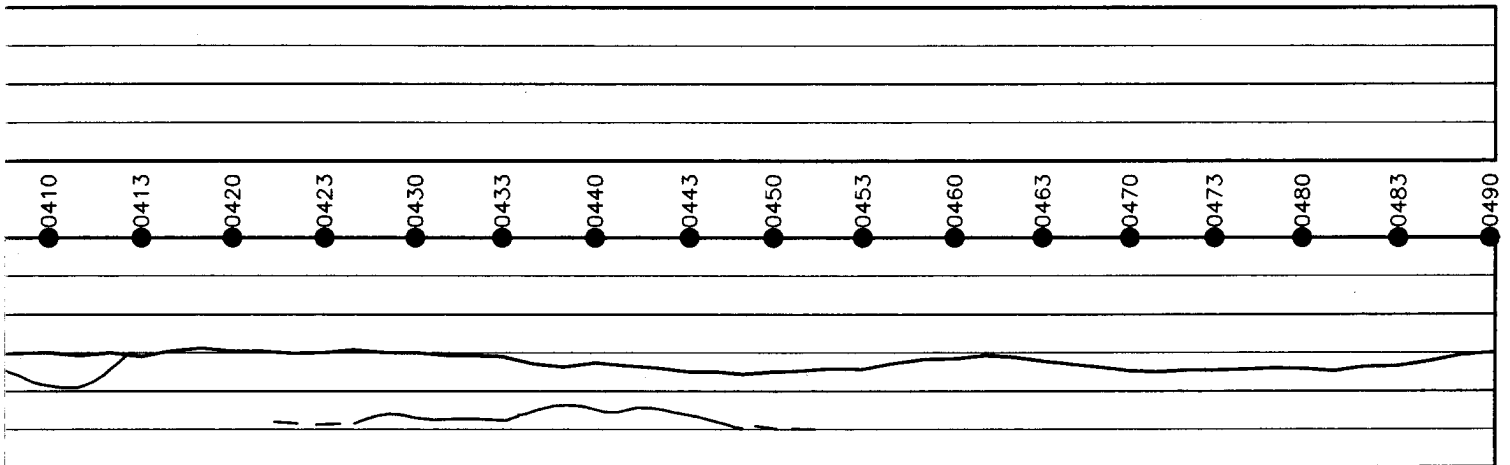
WES SURVEY LINE # P1



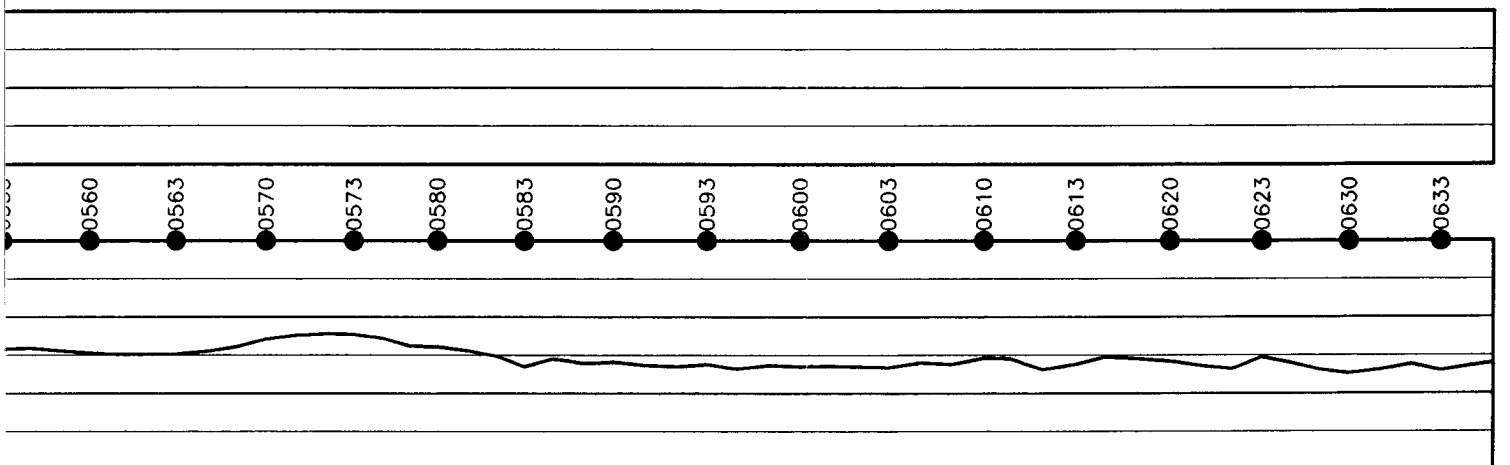
WES SURVEY LINE # P2

PROJECT AREA: POOL 3 NAVIGATION CHANNEL, MONONGAHELA RIVER, PA.

2

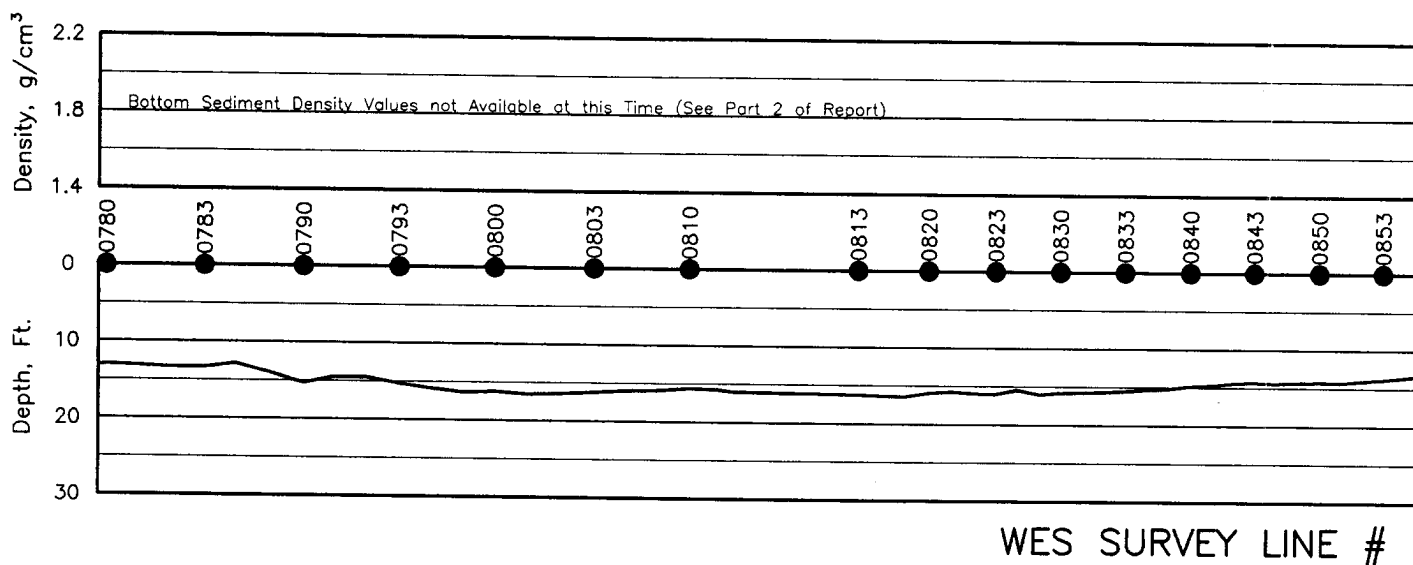
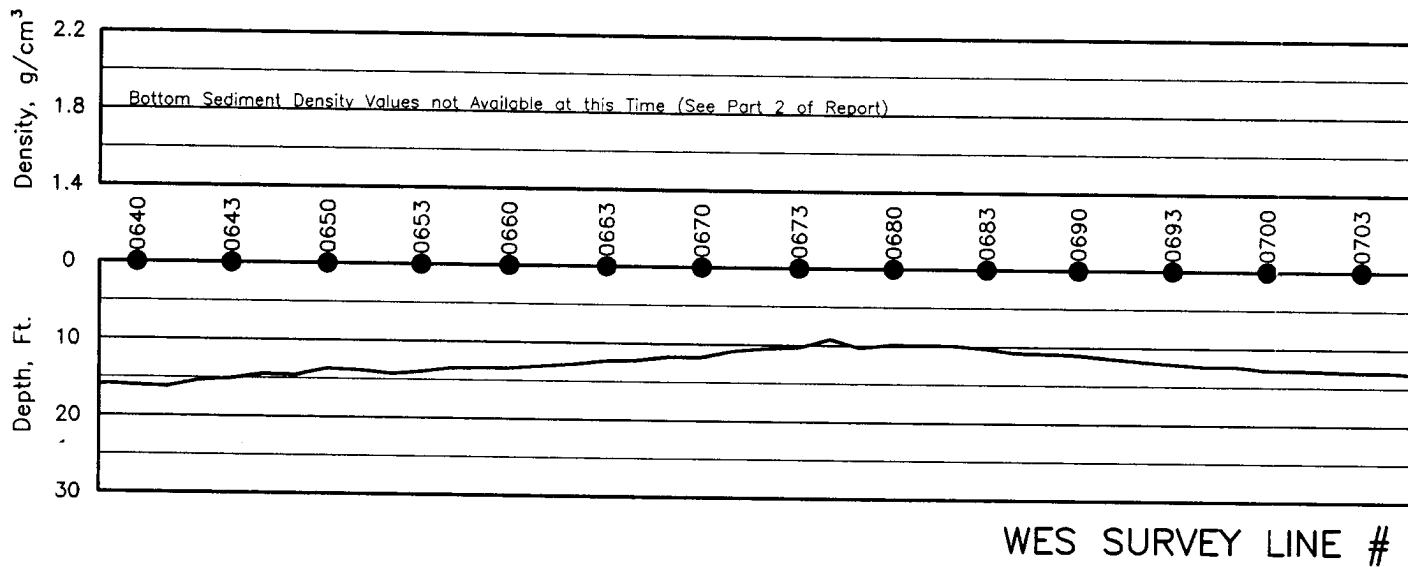


INE # PP3A (cont)



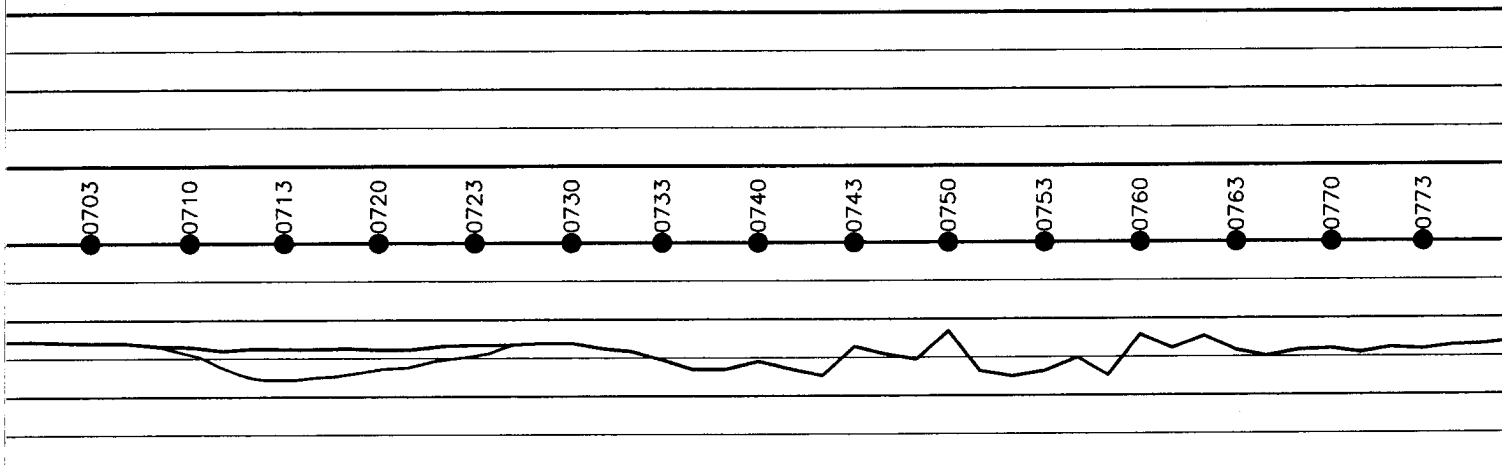
INE # PP3A (cont)

Vertical Exaggeration X 2

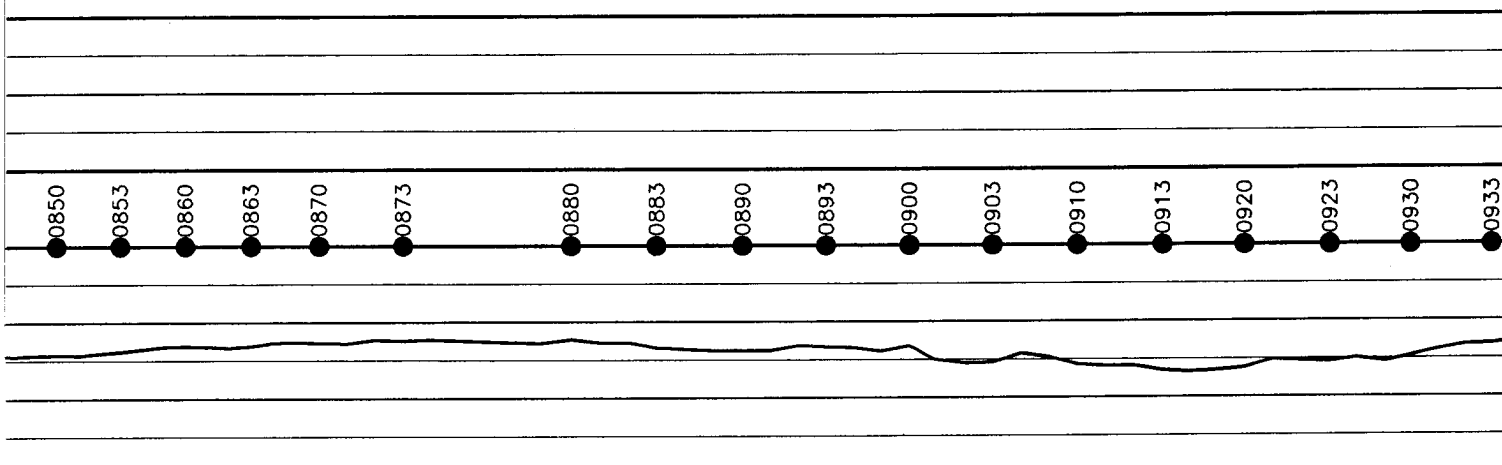


PROJECT AREA: POOL 3 NAVIGATION CHANNEL, MONONGAHELA RIVER, PA.

2

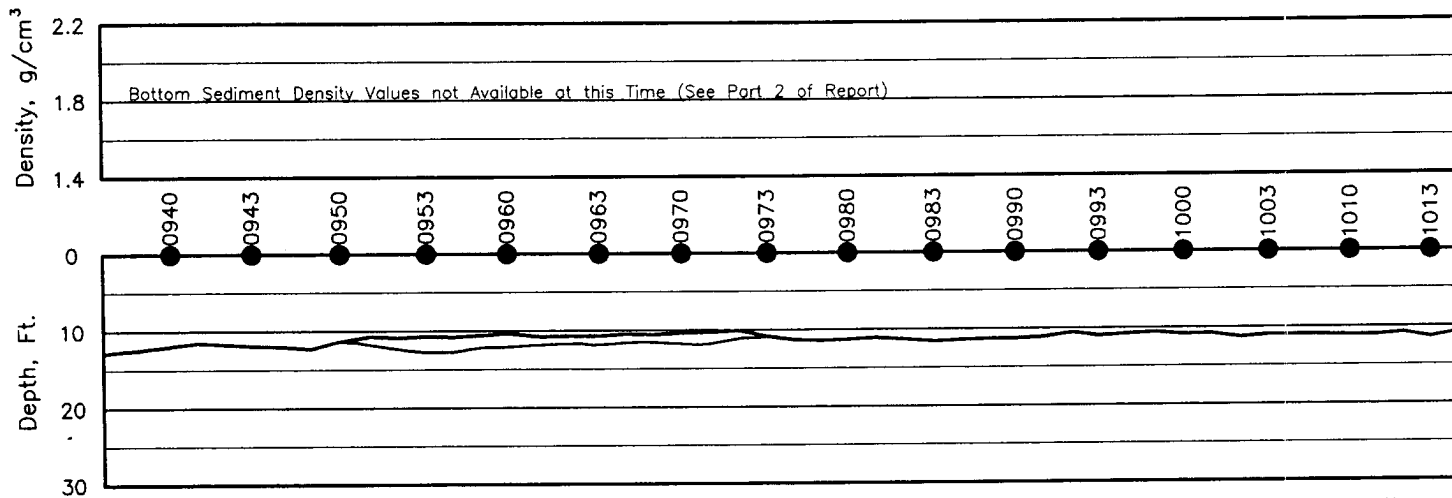


LINE # PP3A (cont)

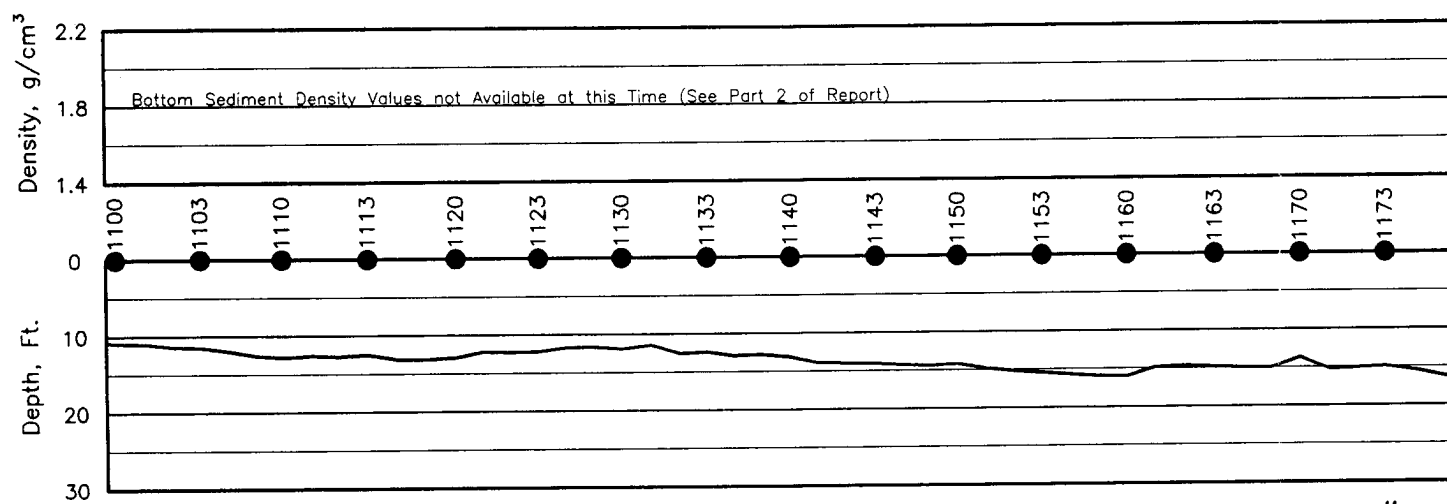


LINE # PP3A (cont)

Vertical Exaggeration X 2



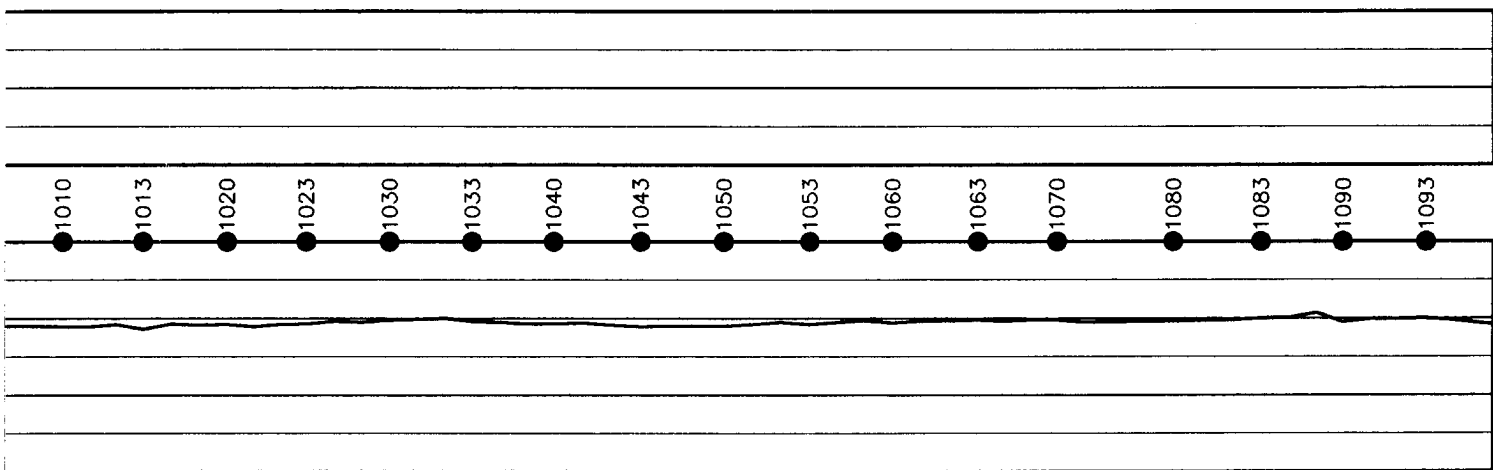
WES SURVEY LINE # PI



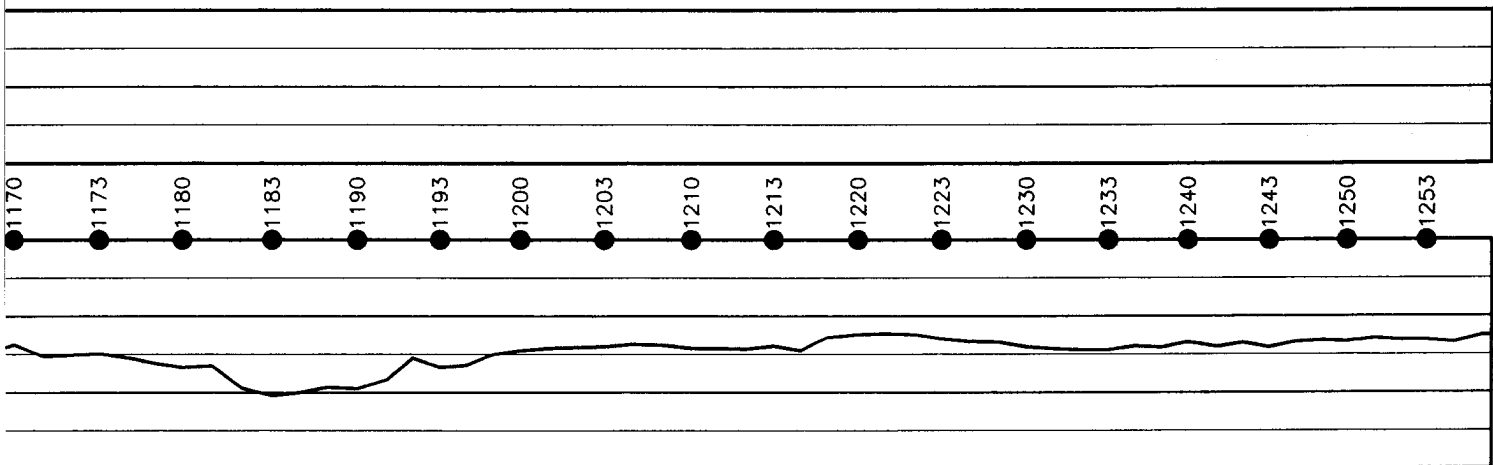
WES SURVEY LINE # P

PROJECT AREA: POOL 3 NAVIGATION CHANNEL, MONONGAHELA RIVER, PA.

2

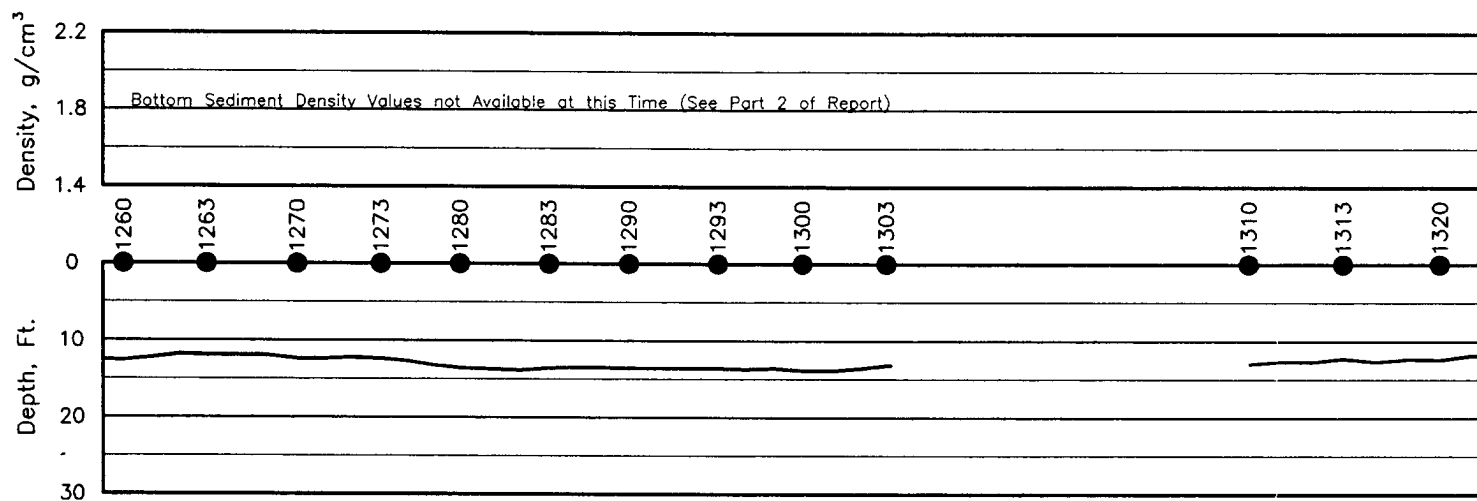


INE # PP3A (cont)

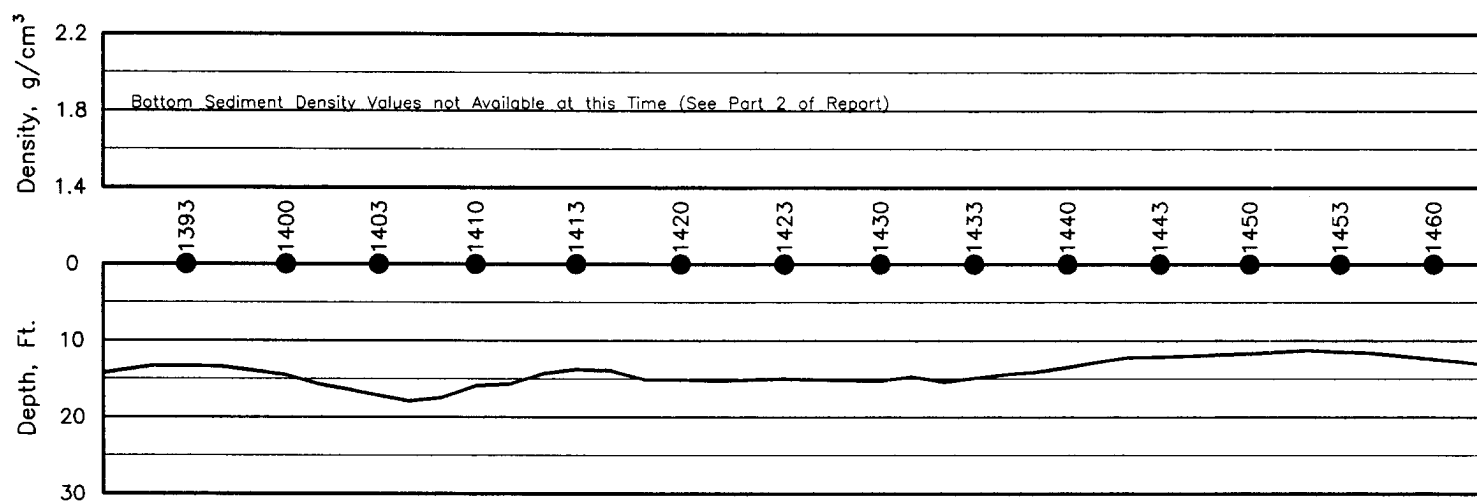


INE # PP3A (cont)

Vertical Exaggeration X 2



WES SURVEY LINE # PP3



WES SURVEY LINE # PP3

PROJECT AREA: POOL 3 NAVIGATION CHANNEL, MONONGAHELA RIVER, PA.

2

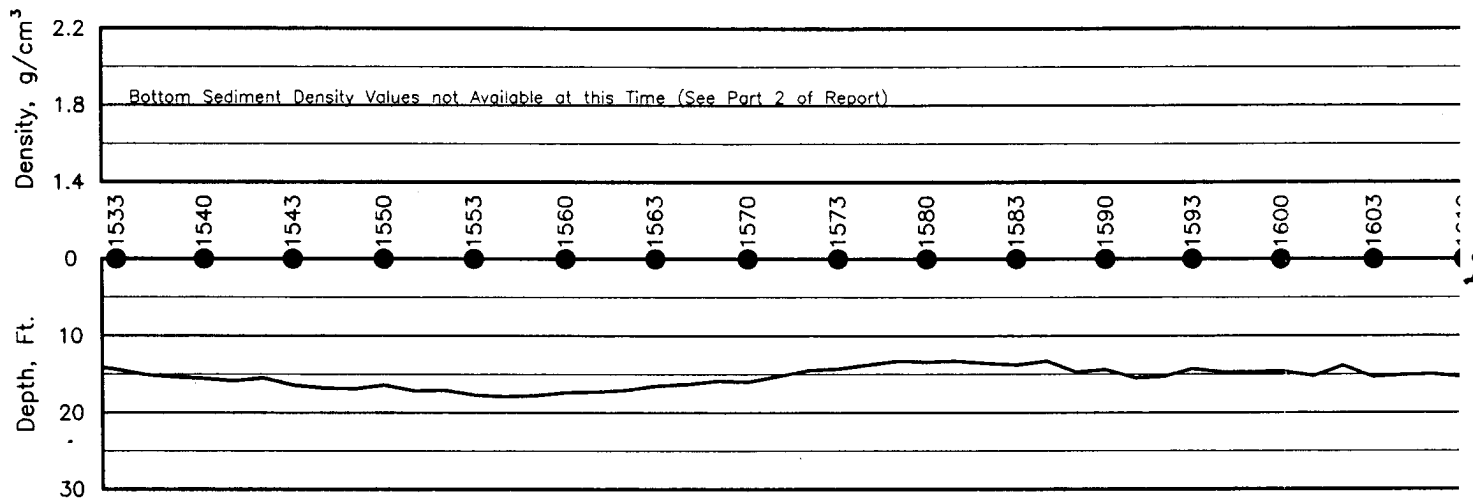
1313 1320 1323 1330 1333 1340 1343 1350 1353 1360 1363 1370 1373 1380 1383 1390

LINE # PP3A (cont)

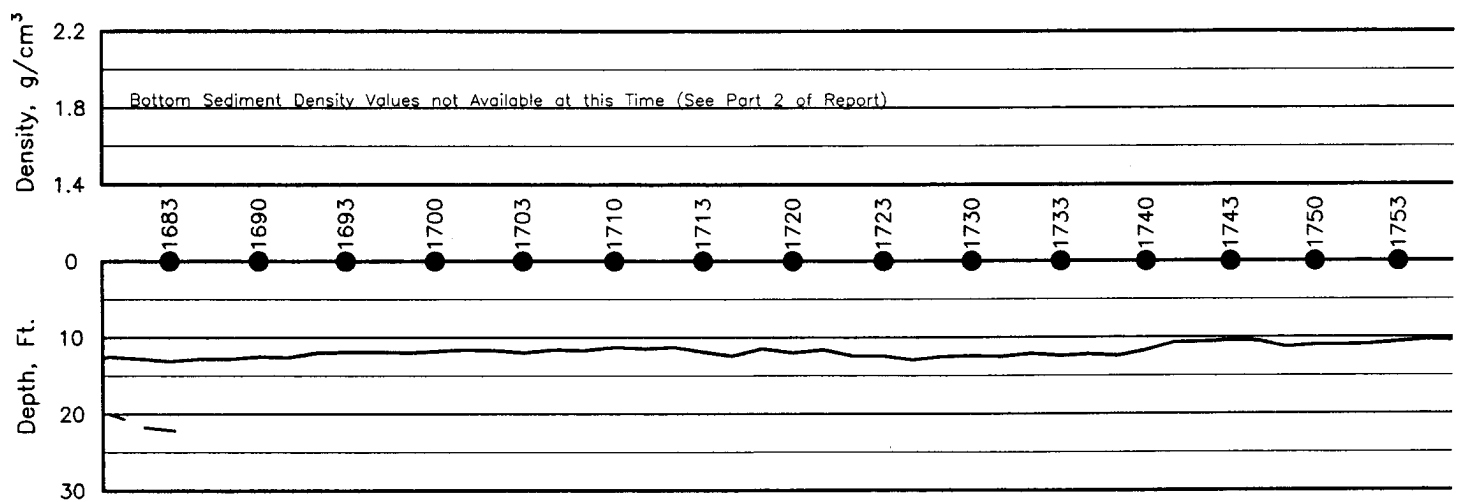
1453 1460 1463 1470 1473 1480 1483 1490 1493 1500 1503 1510 1513 1520 1523 1530

LINE # PP3A (cont)

Vertical Exaggeration X 2



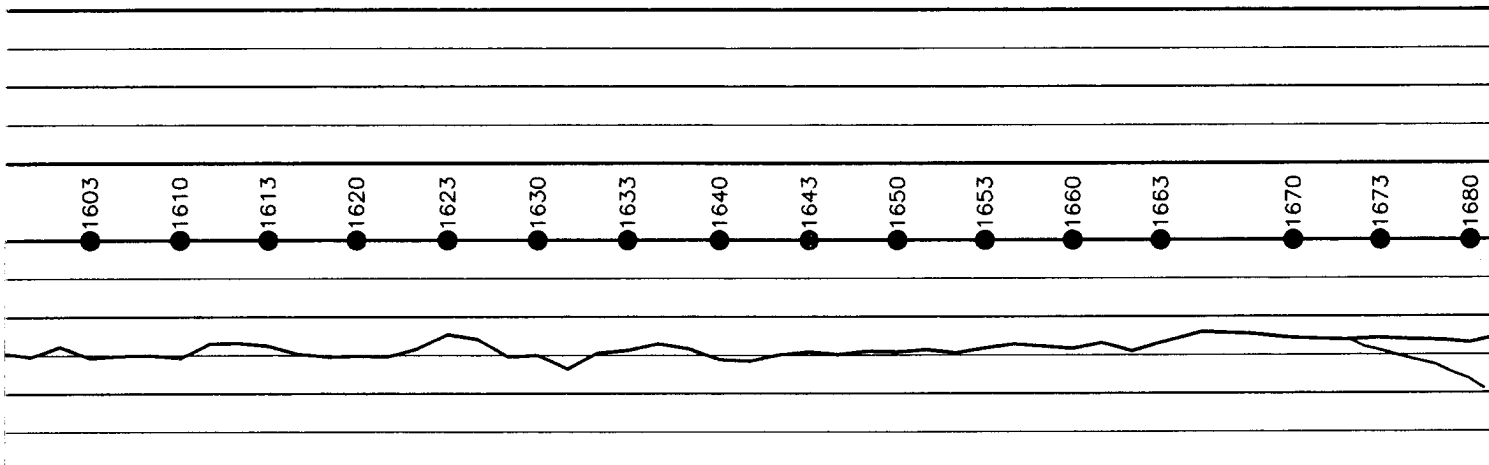
WES SURVEY LINE # PF



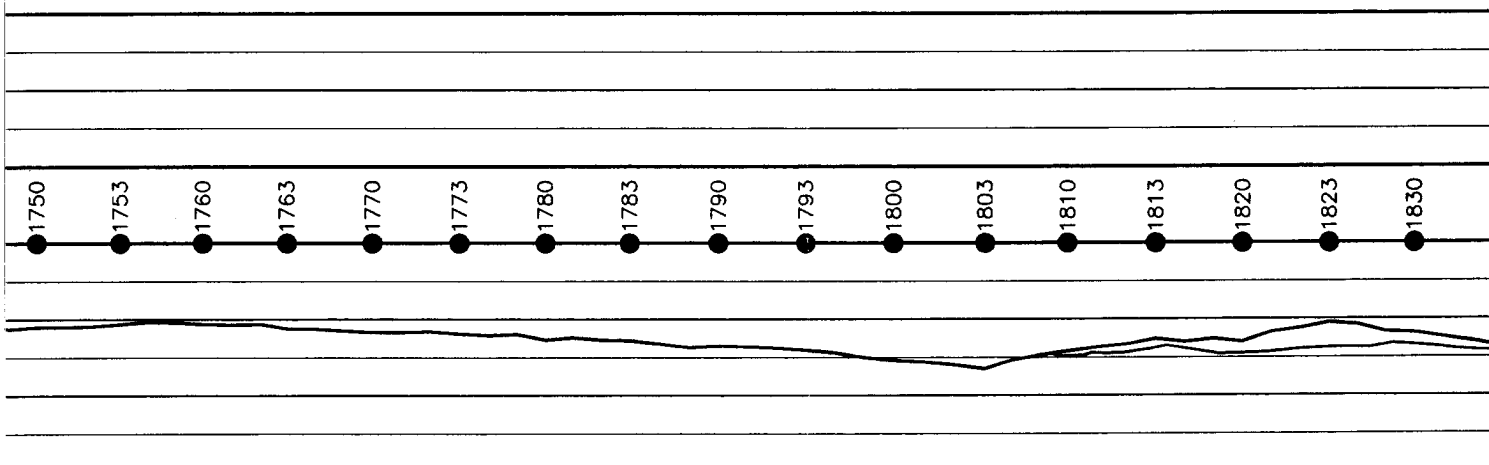
WES SURVEY LINE # PF

PROJECT AREA: POOL 3 NAVIGATION CHANNEL, MONONGAHELA RIVER, PA.

3

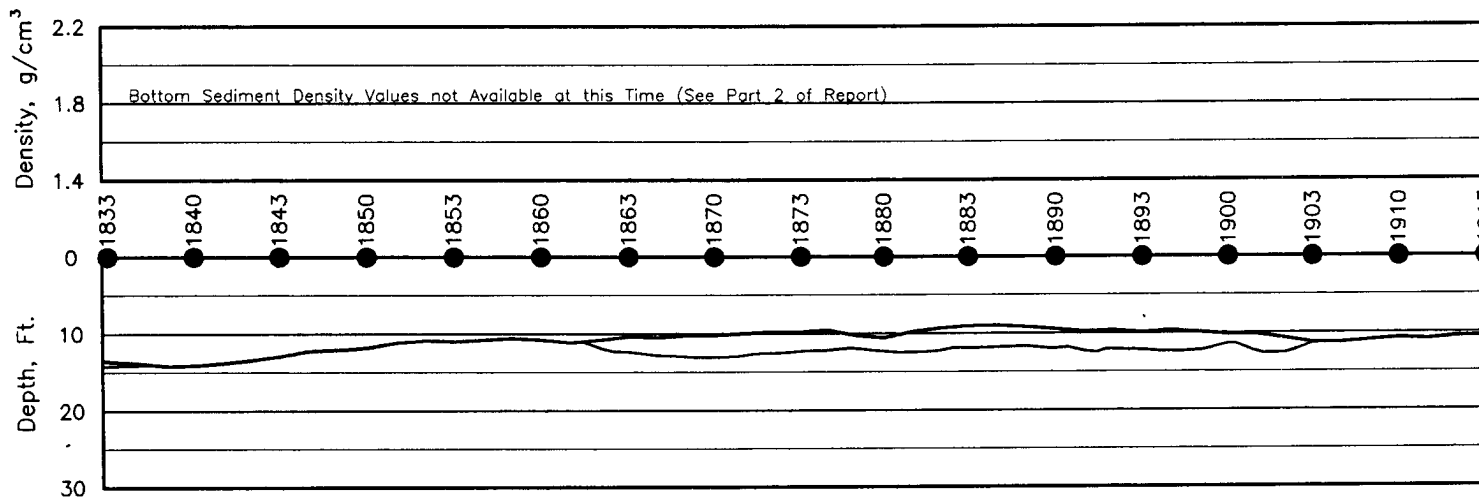


LINE # PP3A (cont)

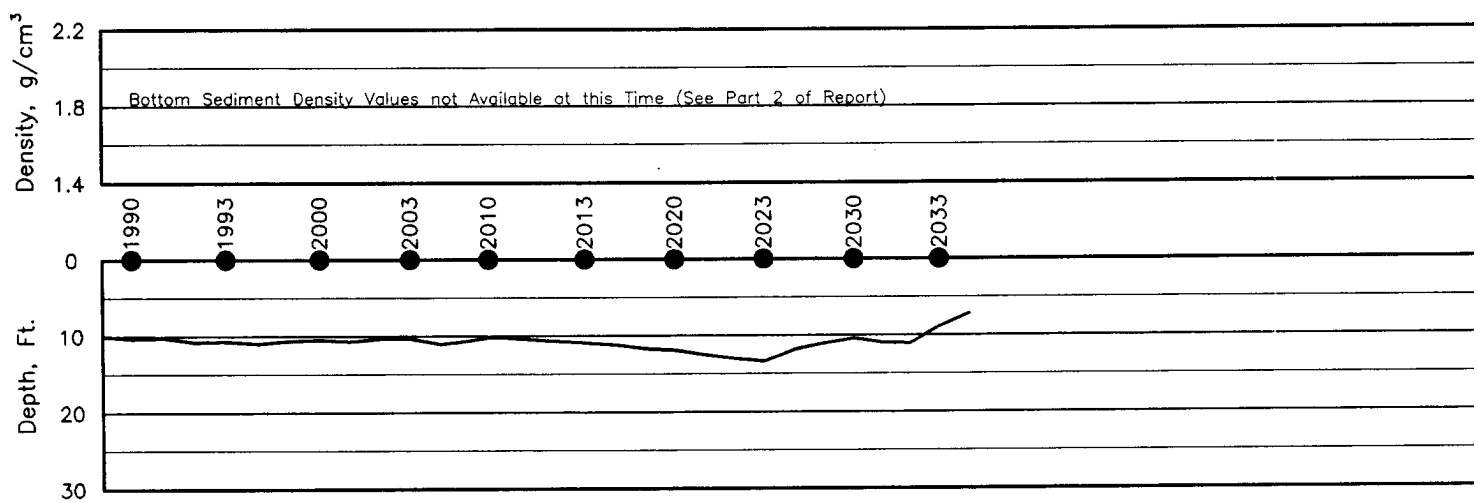


LINE # PP3A (cont)

Vertical Exaggeration X 2



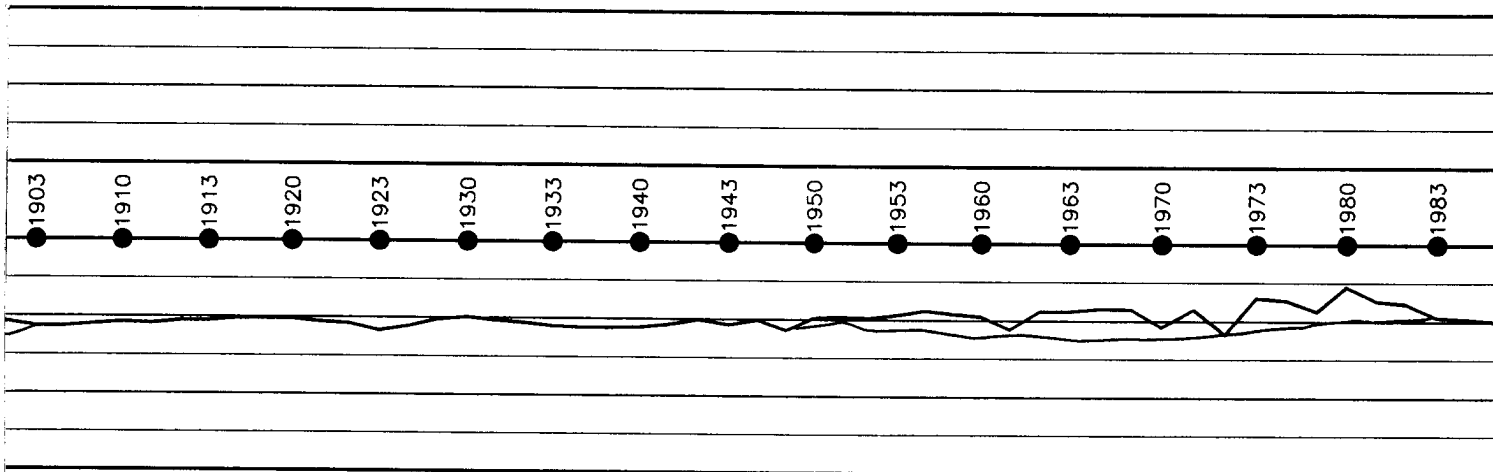
WES SURVEY LINE # PP.



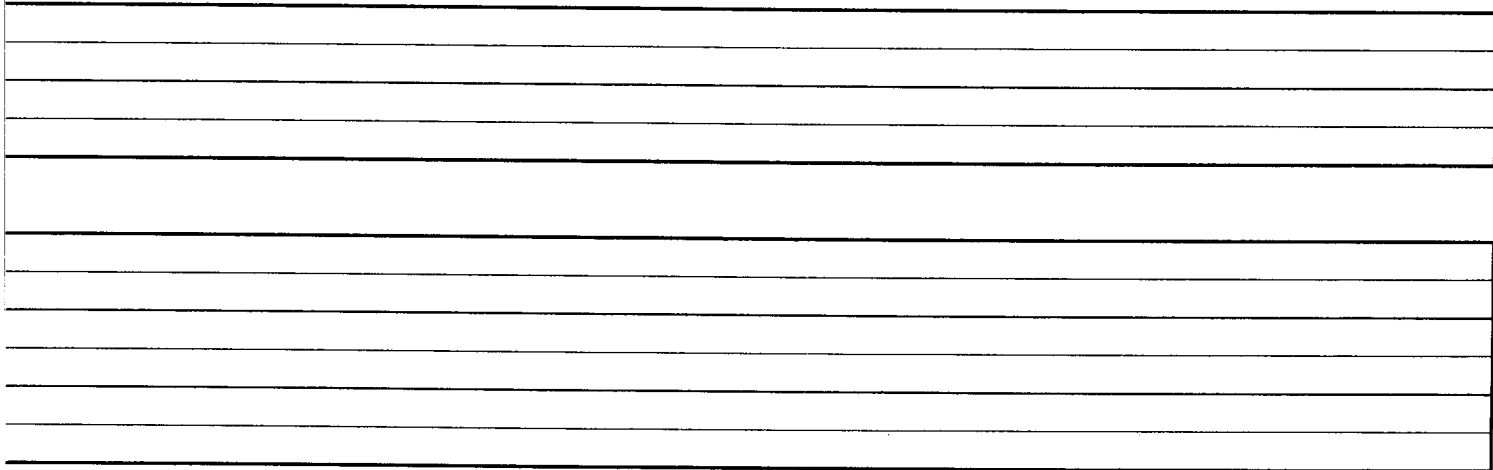
WES SURVEY LINE # PP.

PROJECT AREA: POOL 3 NAVIGATION CHANNEL, MONONGAHELA RIVER, PA.

2

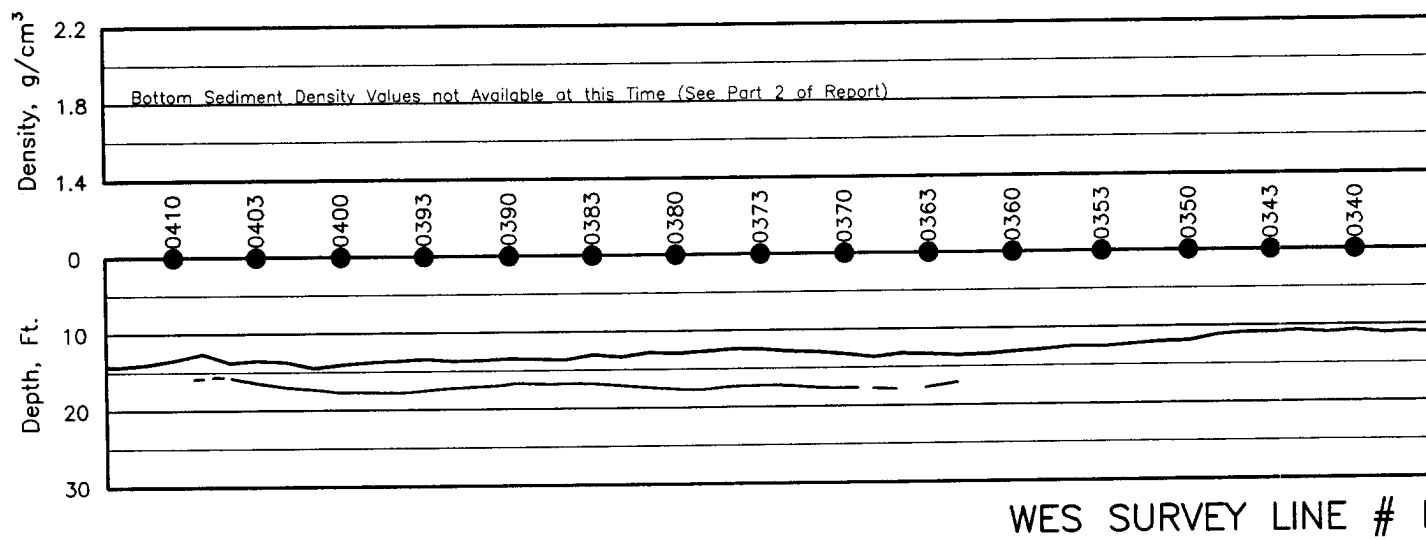
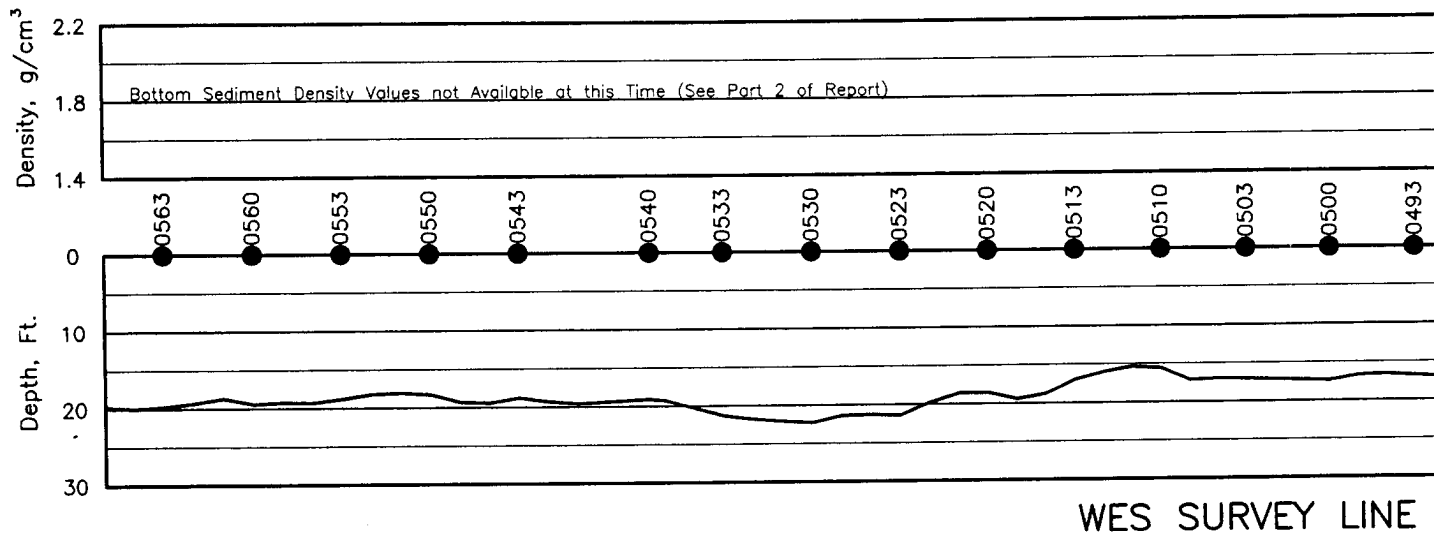


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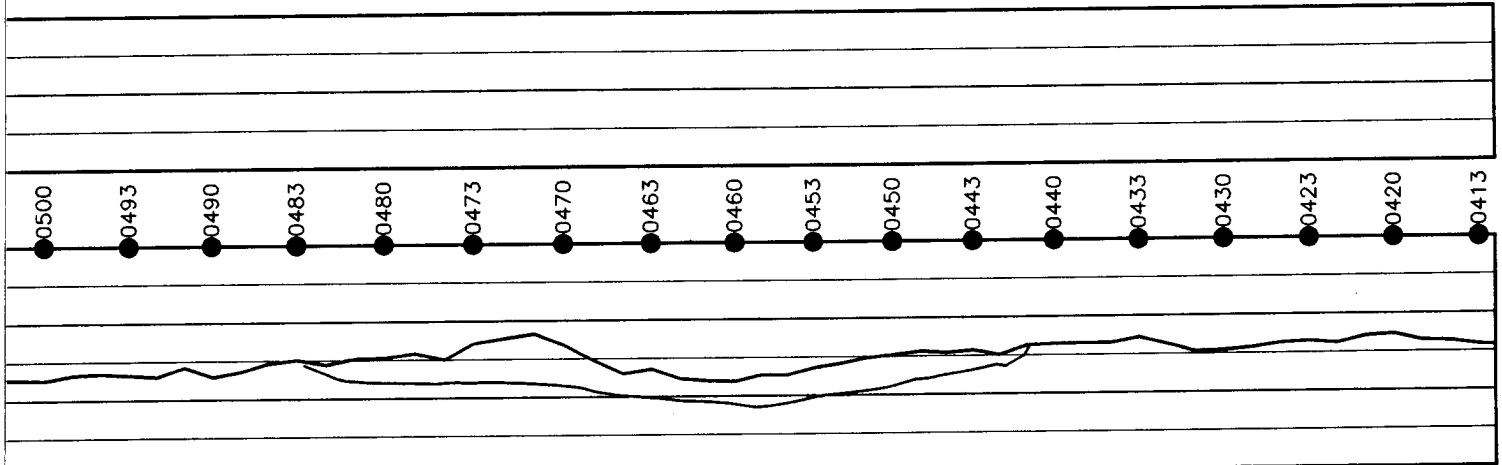
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Vertical Exaggeration X 2

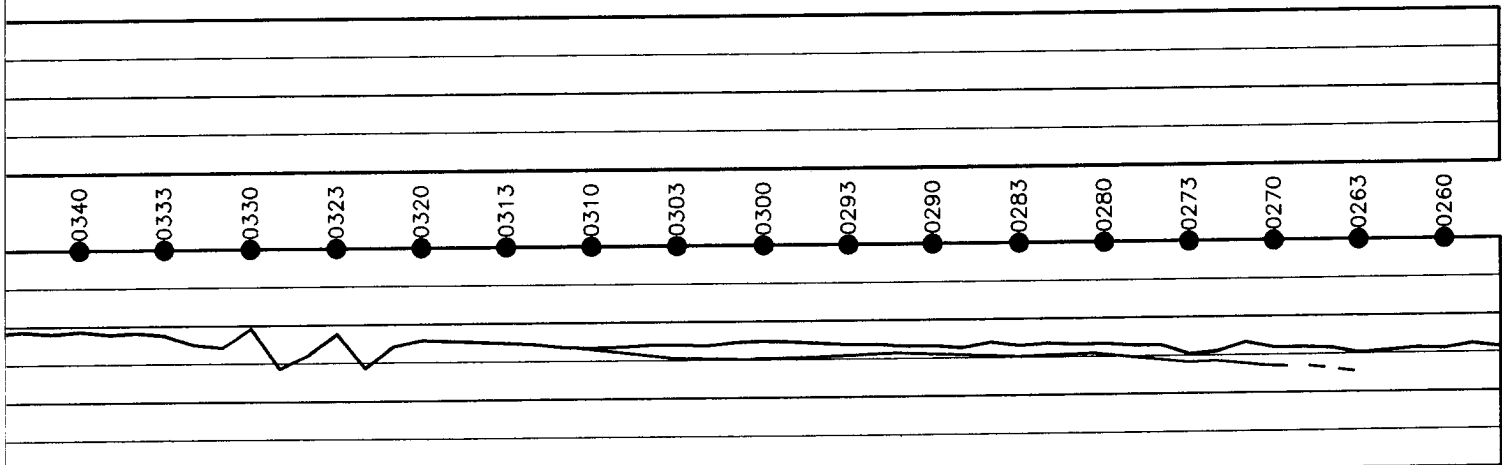


PROJECT AREA: POOL 3 NAVIGATION CHANNEL, MONONGAHELA RIVER, PA.

2

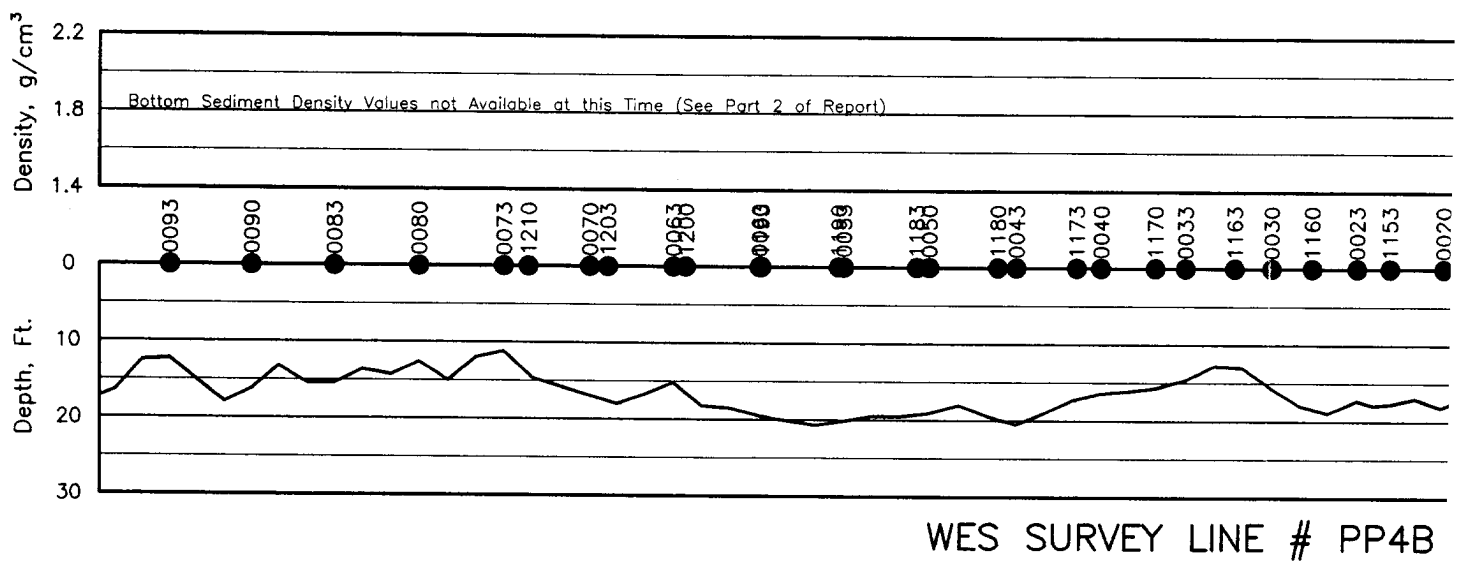
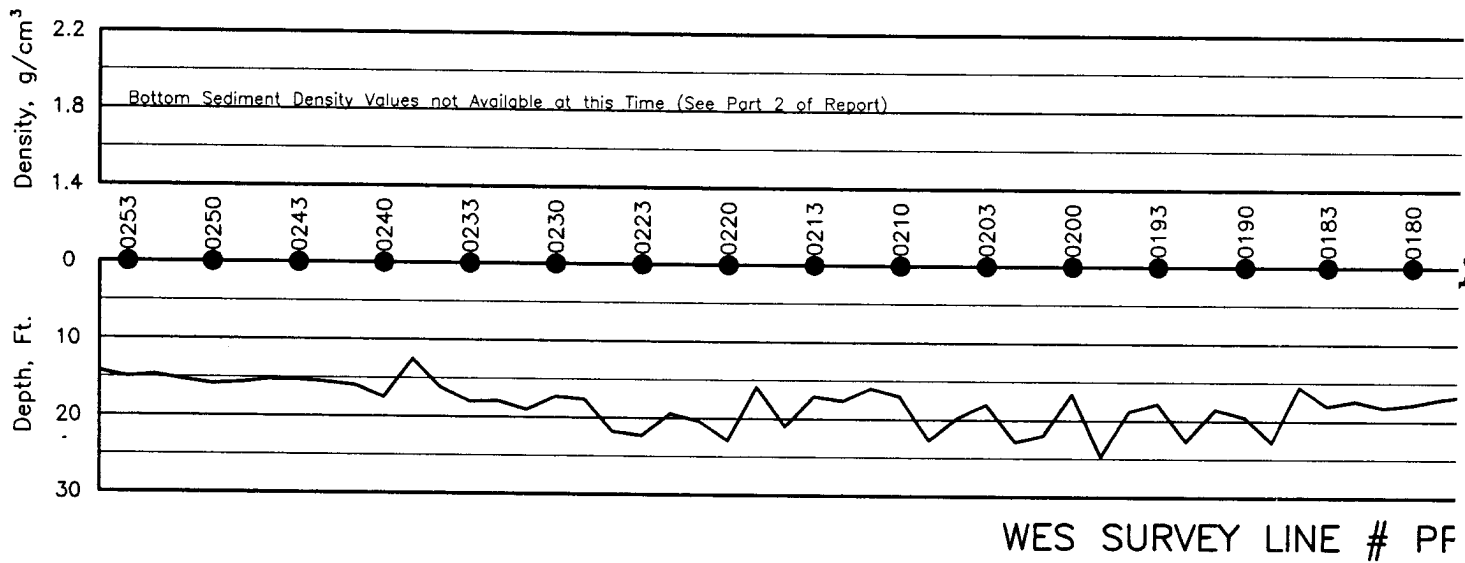


Y LINE # PP4B



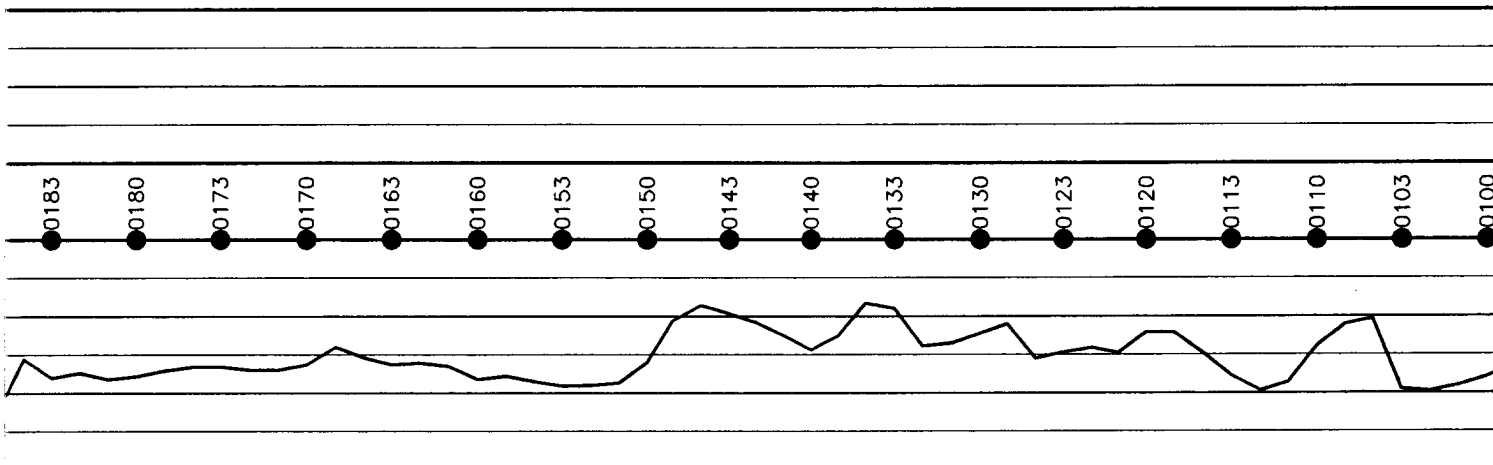
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Vertical Exaggeration X 2

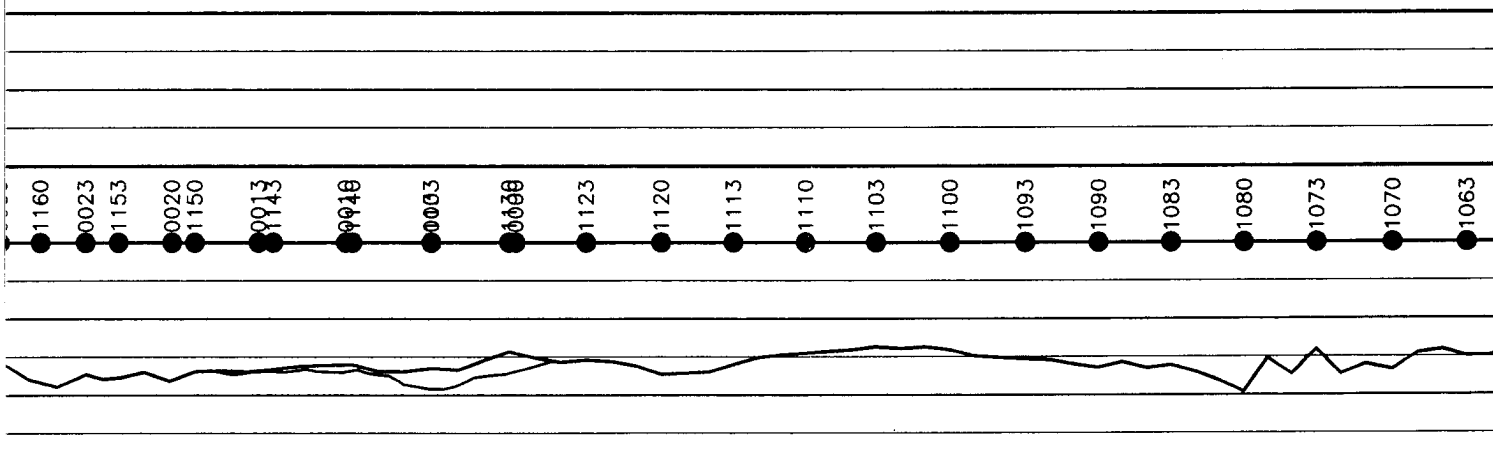


PROJECT AREA: POOL 3 NAVIGATION CHANNEL, MONONGAHELA RIVER, PA.

2

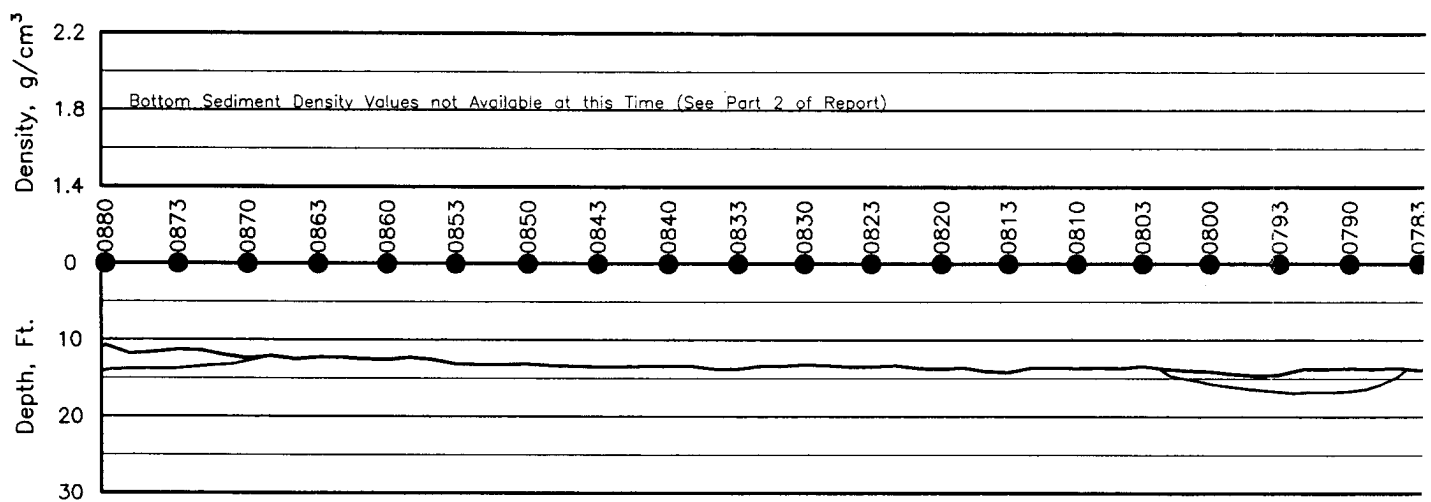
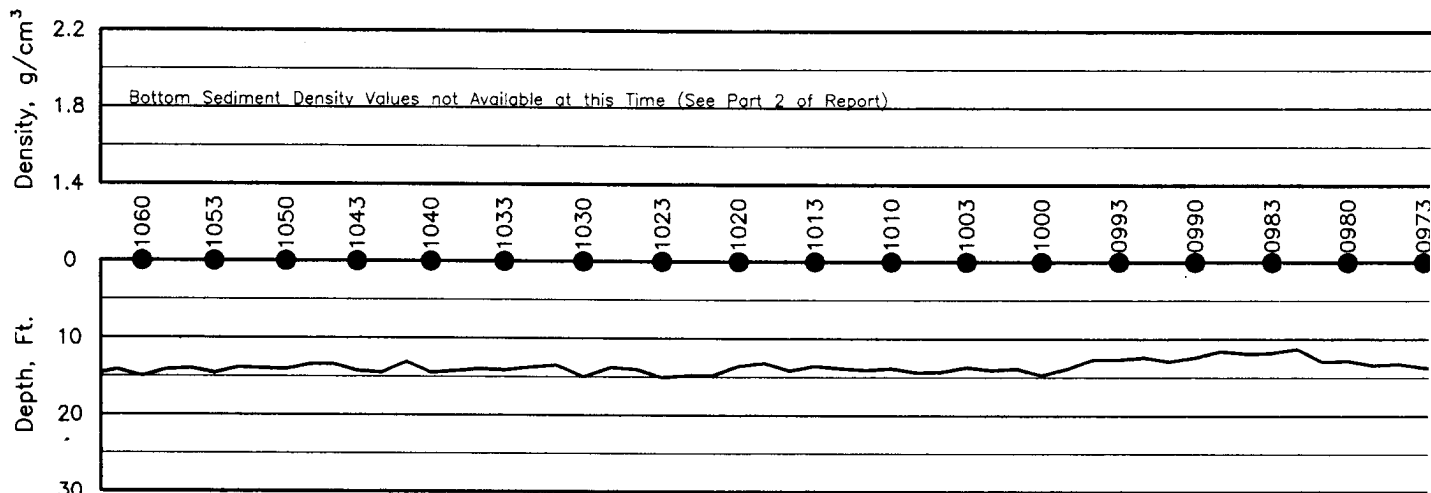


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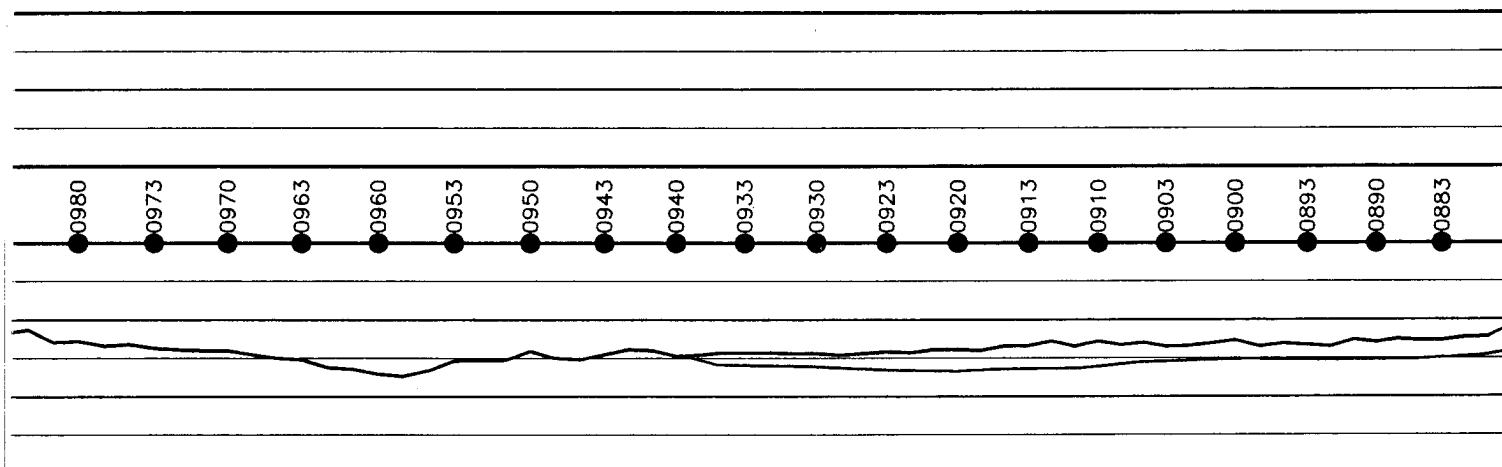
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Vertical Exaggeration X 2

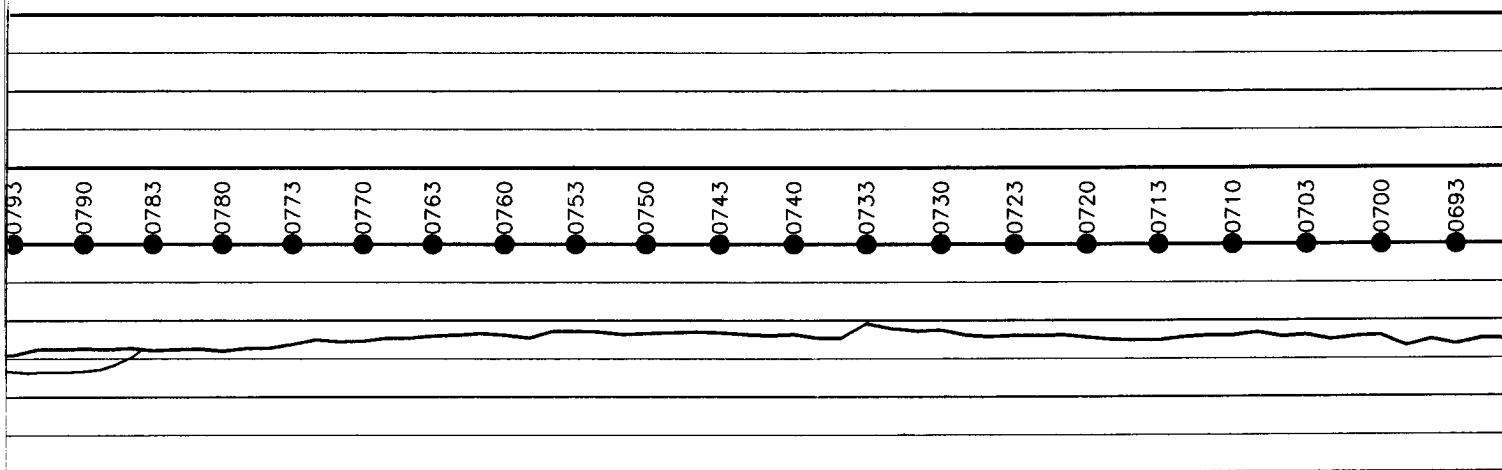


PROJECT AREA: POOL 3 NAVIGATION CHANNEL, MONONGAHELA RIVER, PA.

2

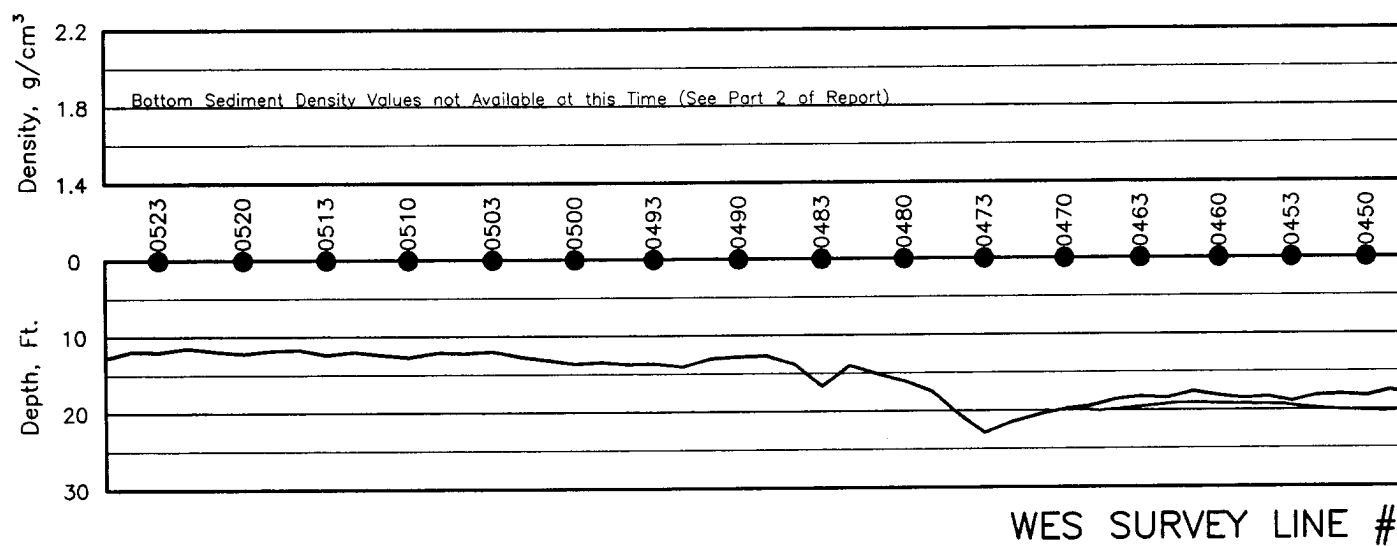
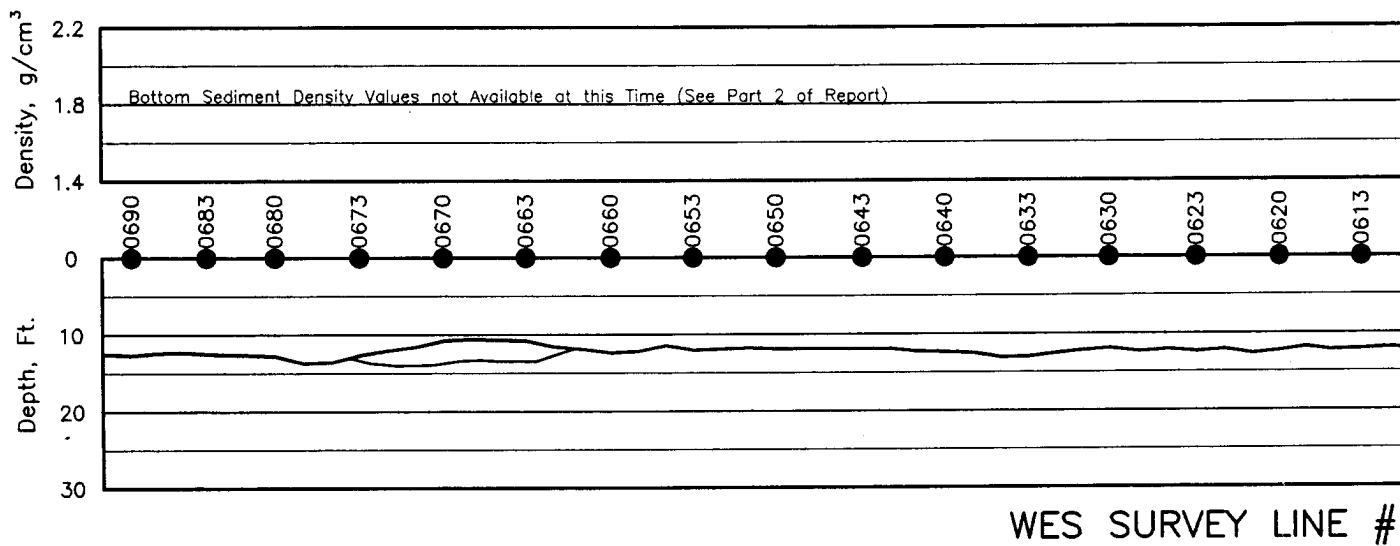


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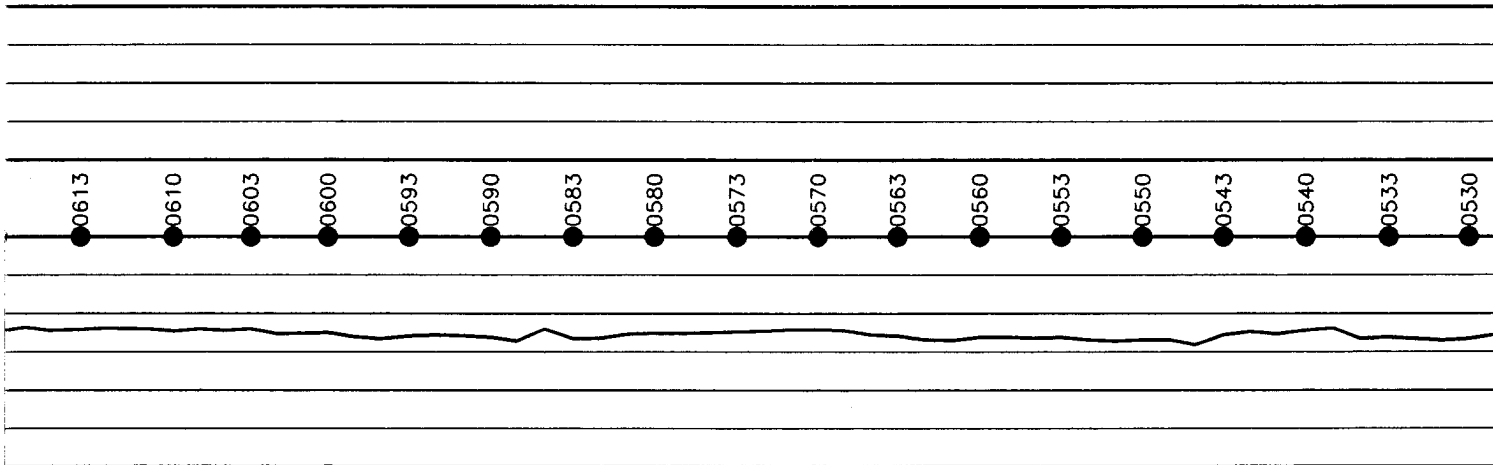
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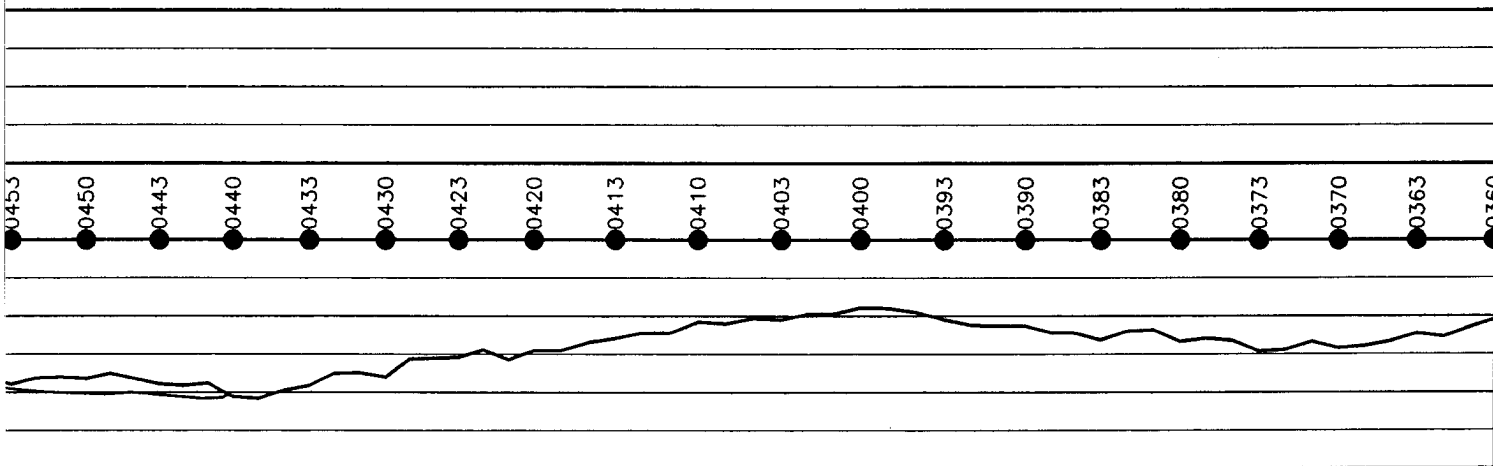


PROJECT AREA: POOL 3 NAVIGATION CHANNEL, MONONGAHELA RIVER, PA

2

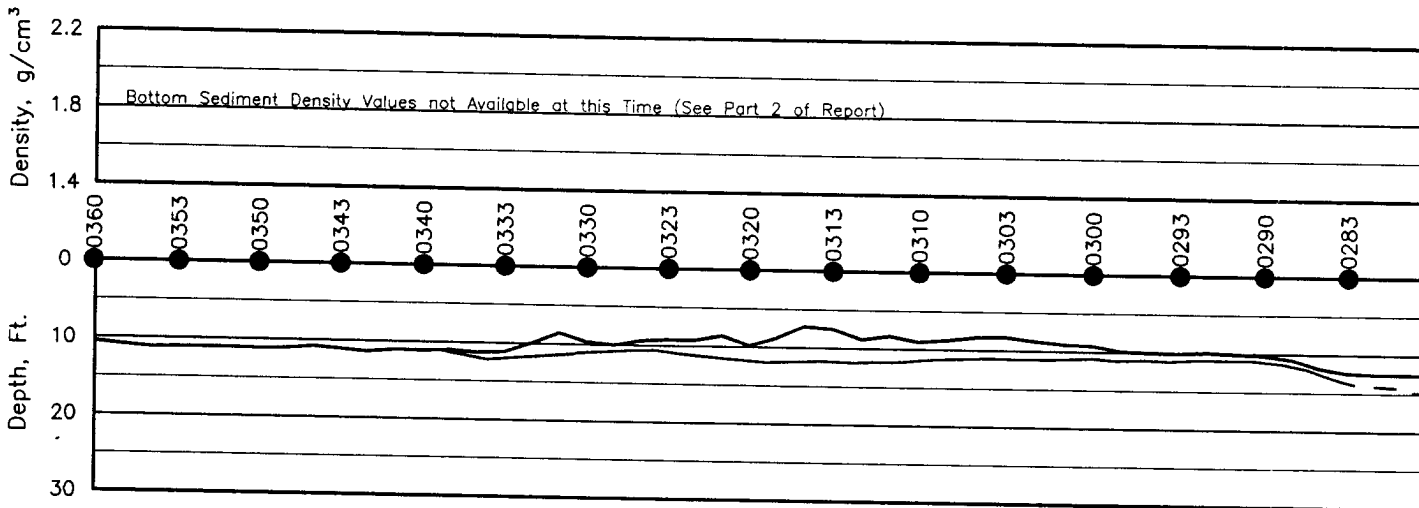


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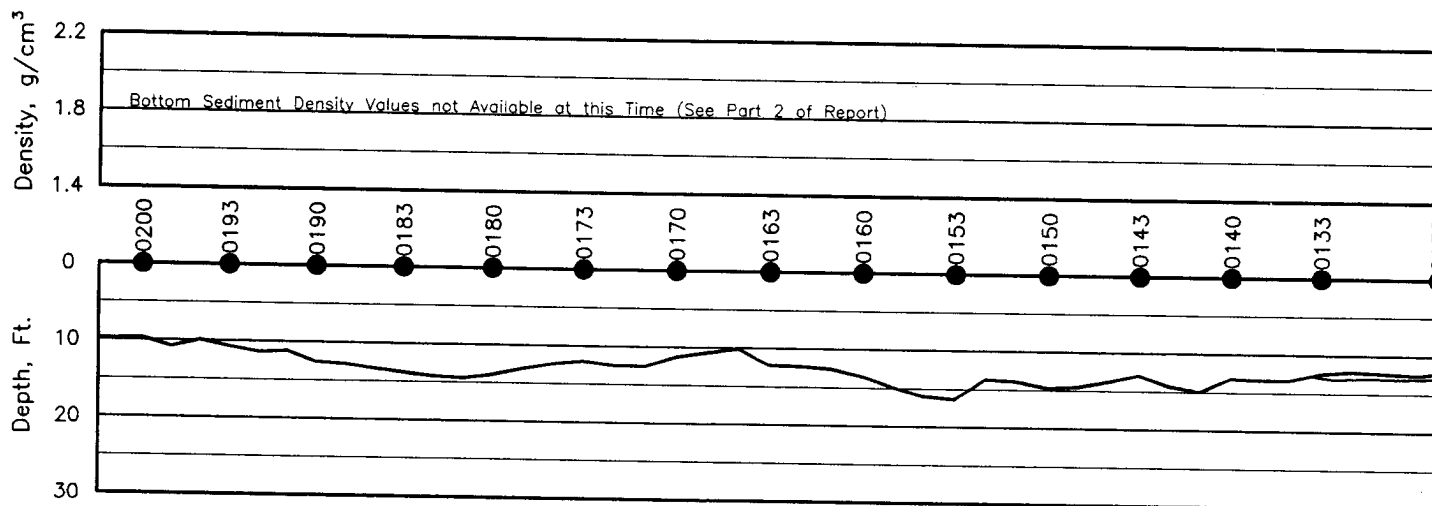


LINE # PP4A (cont)

Vertical Exaggeration X 2



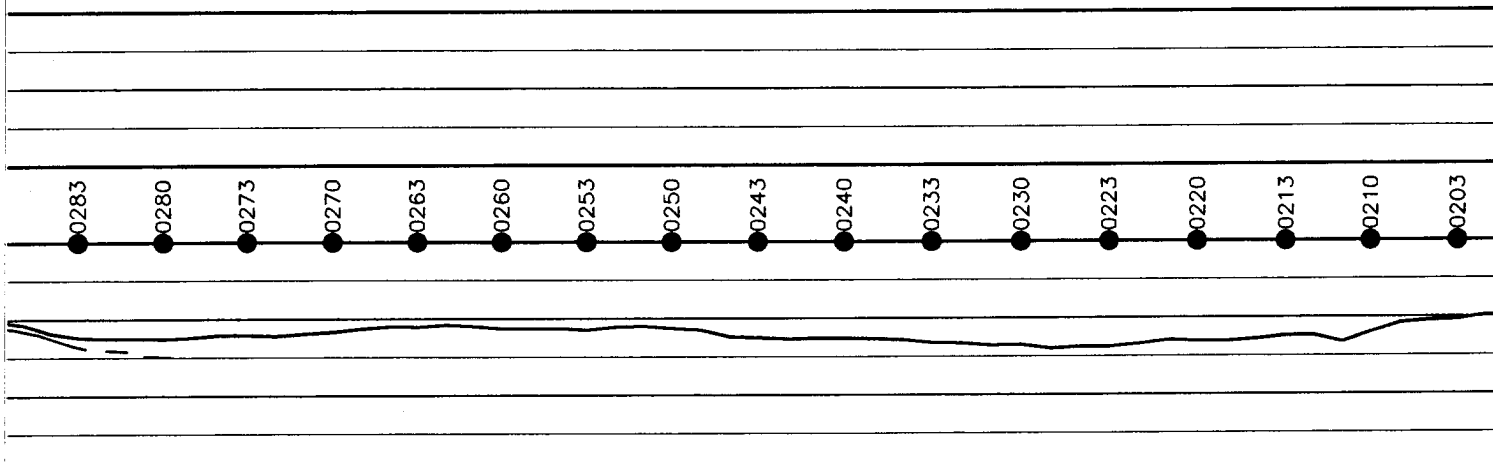
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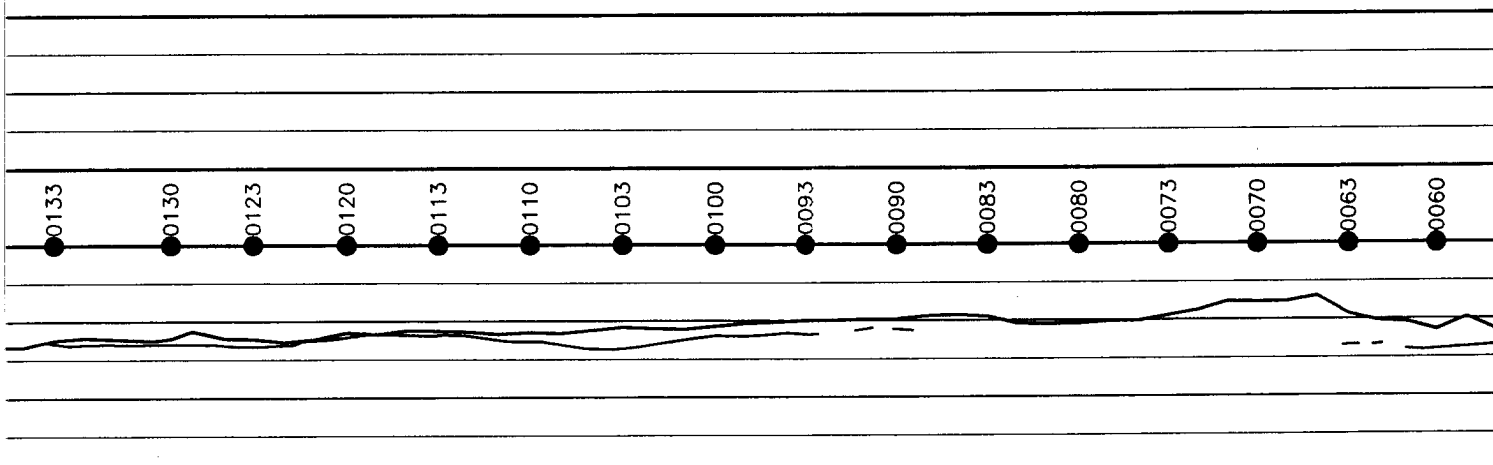
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PROJECT AREA: POOL 3 NAVIGATION CHANNEL, MONONGAHELA RIVER, PA.

2

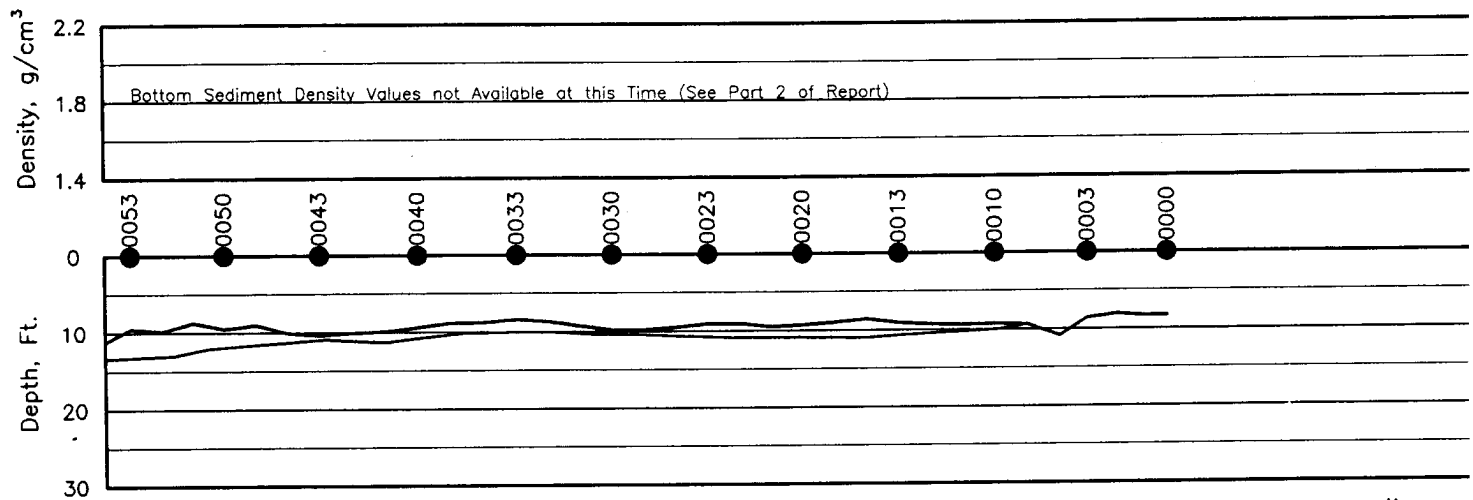


LINE # PP4A (cont)



LINE # PP4A (cont)

Vertical Exaggeration X 2

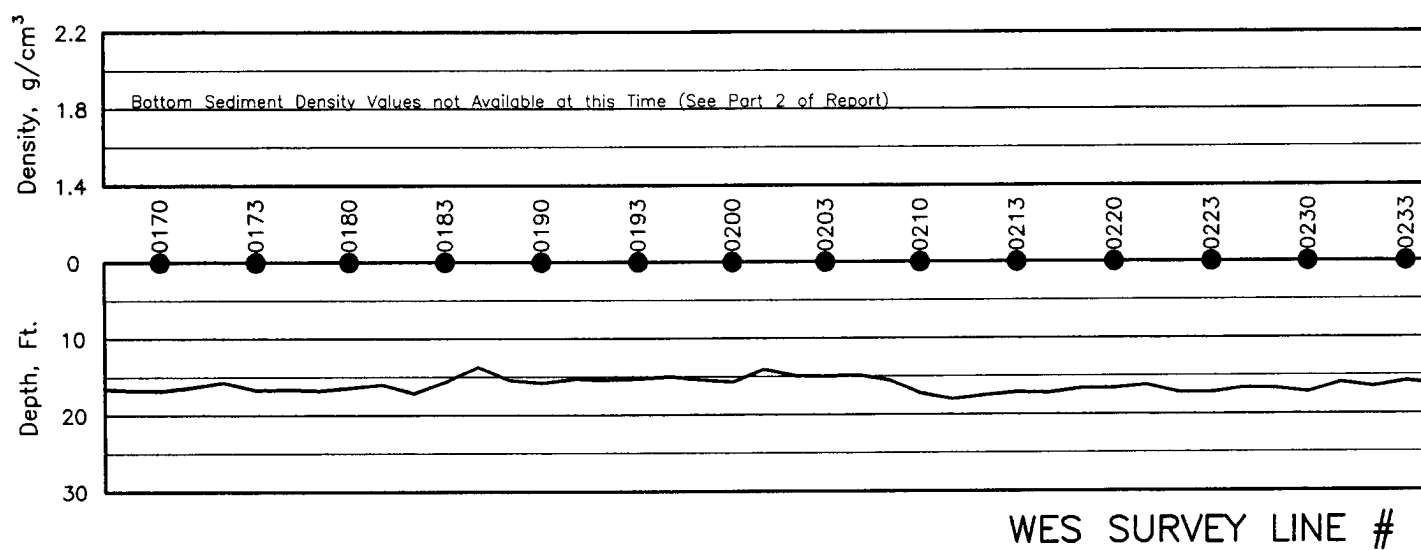
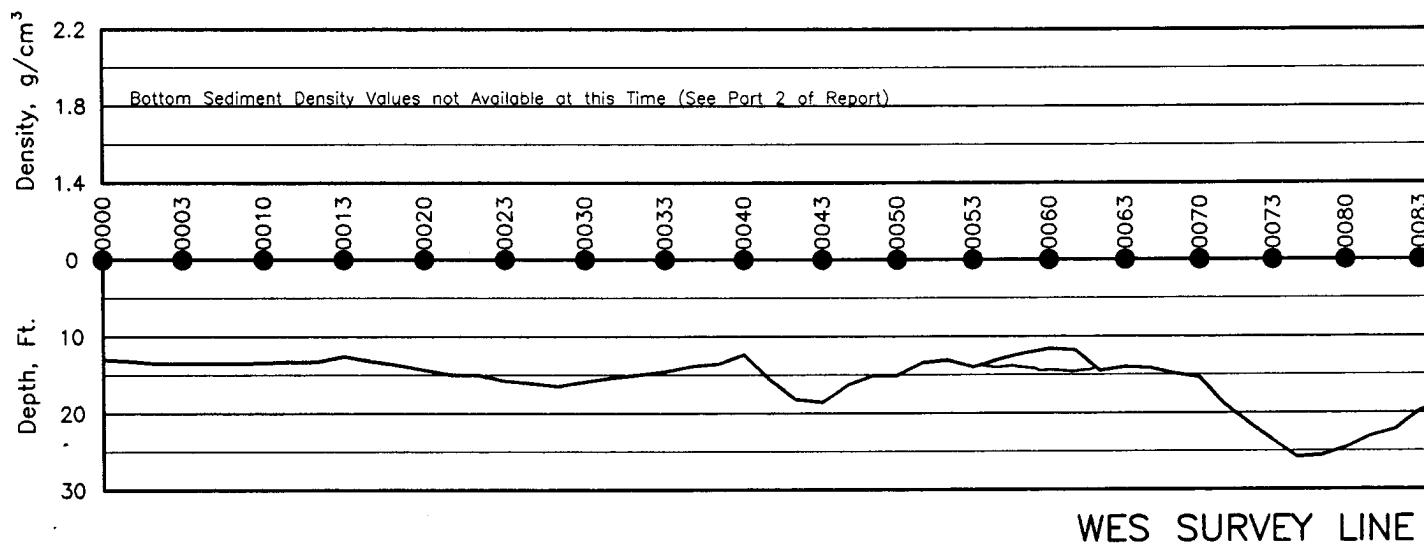


PROJECT AREA: POOL 3 NAVIGATION CHANNEL, MONONGAHELA RIVER, PA.

2

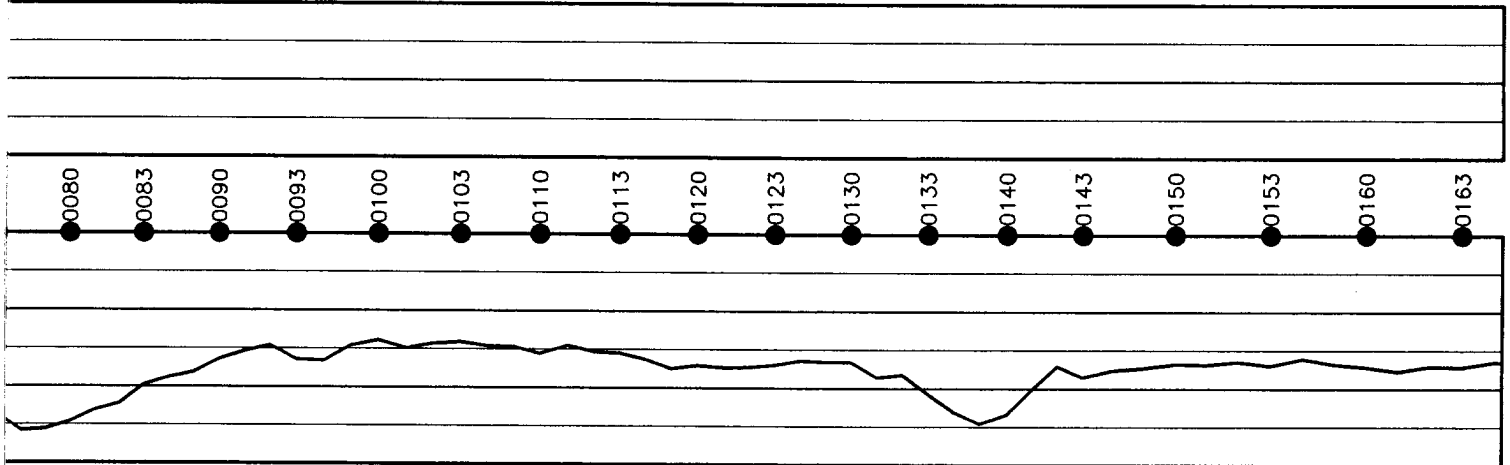
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Vertical Exaggeration X 2

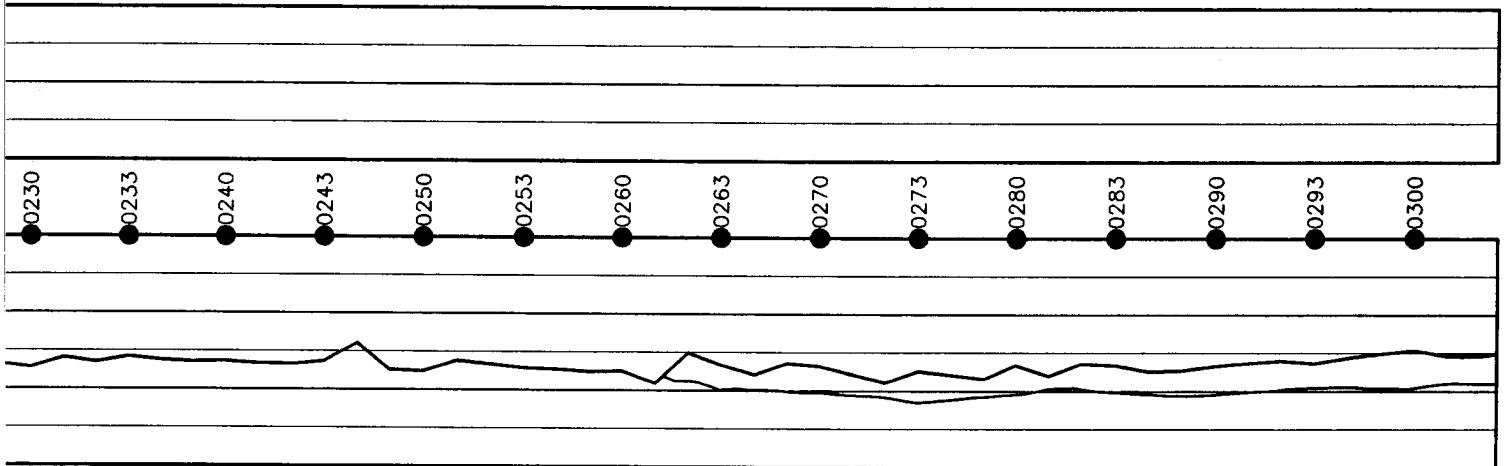


PROJECT AREA: POOL 3 NAVIGATION CHANNEL, MONONGAHELA RIVER, PA.

2

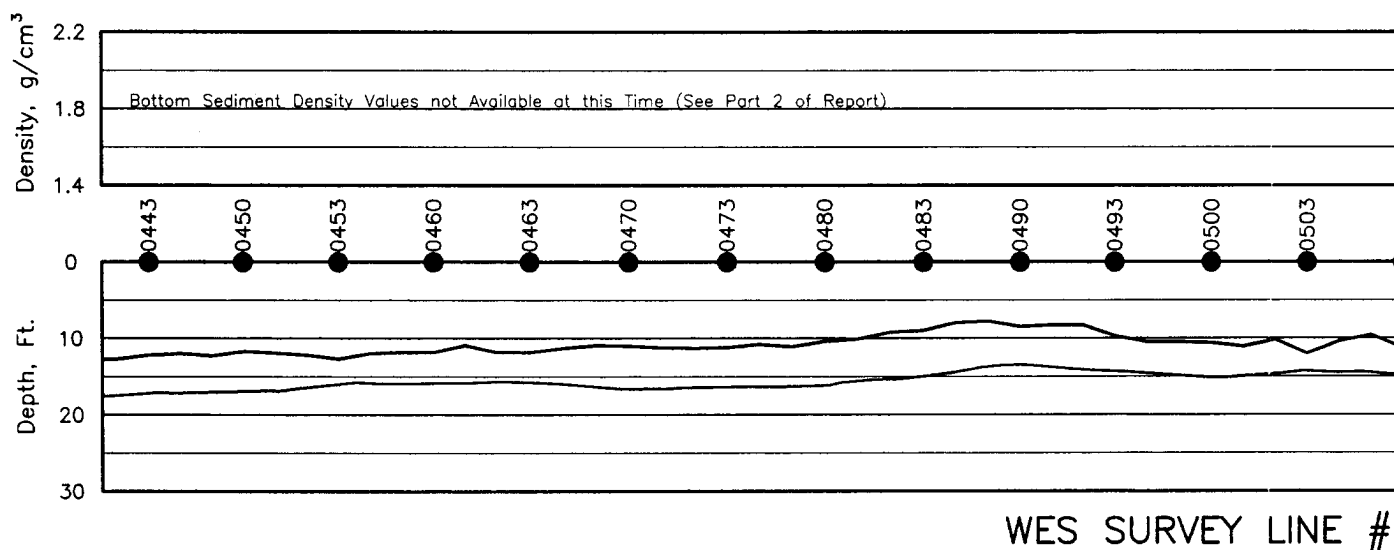
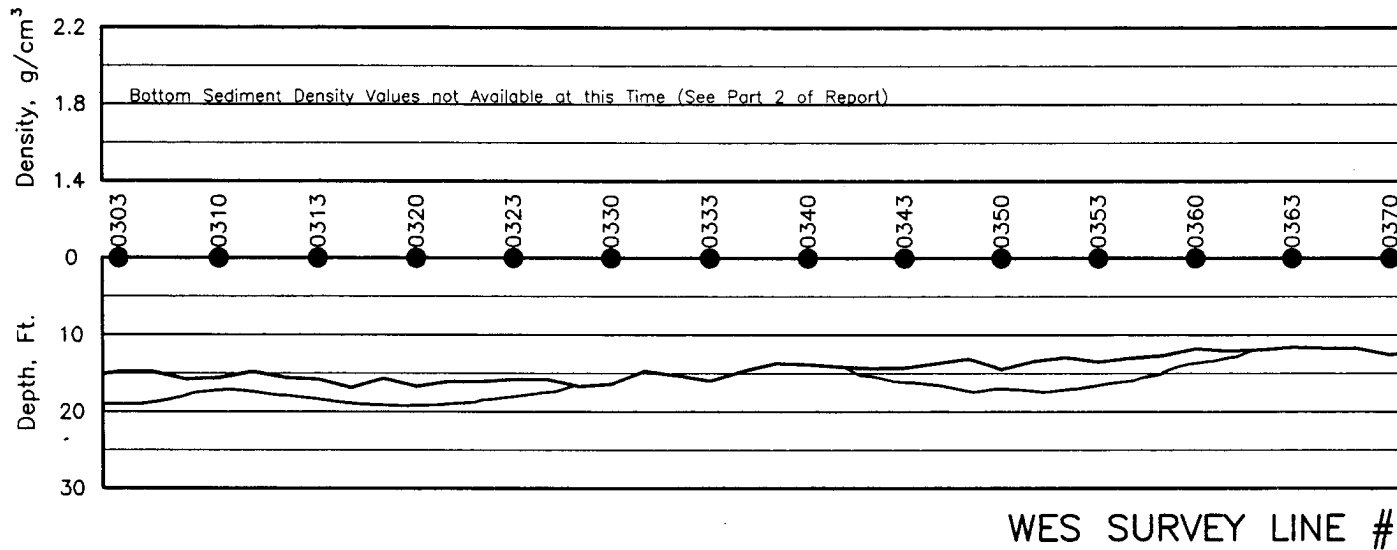


Y LINE # PP5A



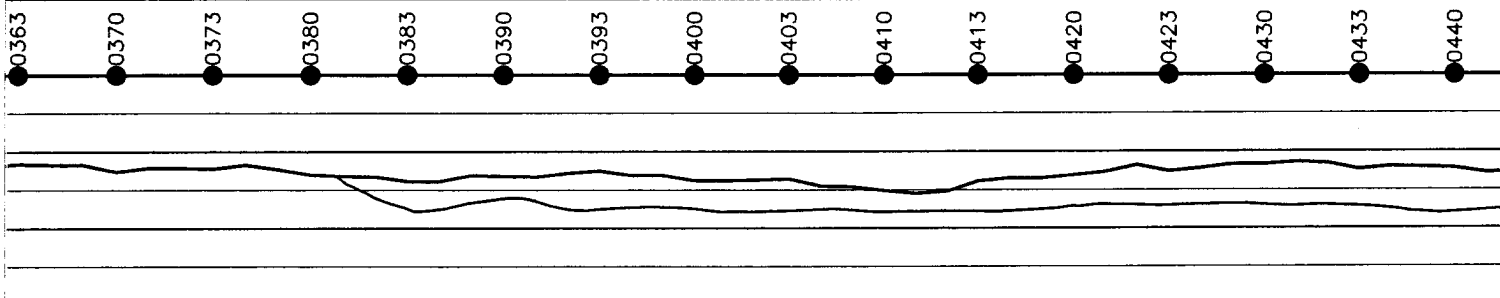
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Vertical Exaggeration X 2

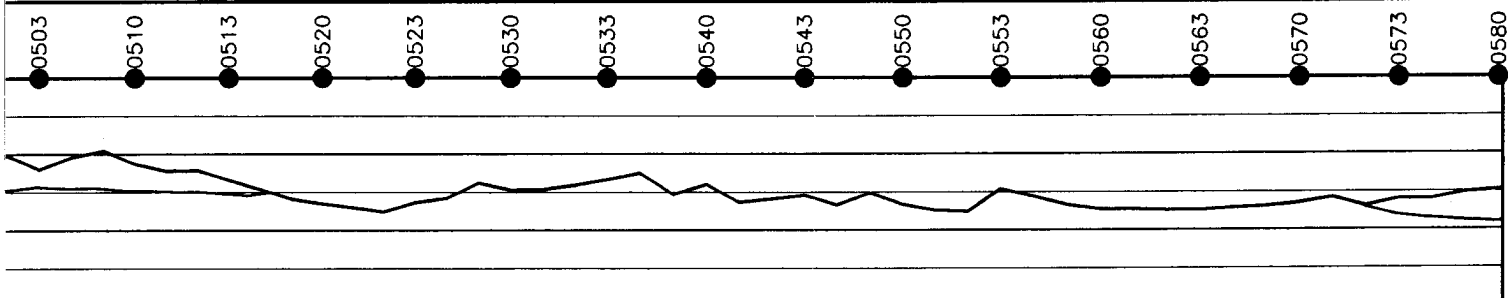


PROJECT AREA: POOL 3 NAVIGATION CHANNEL, MONONGAHELA RIVER, PA

2

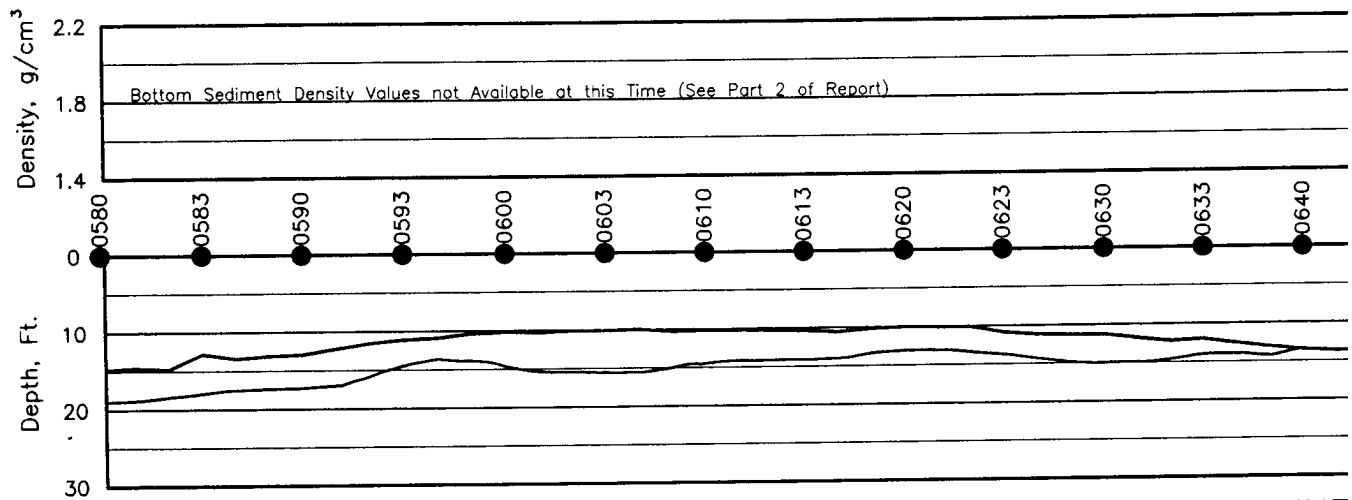


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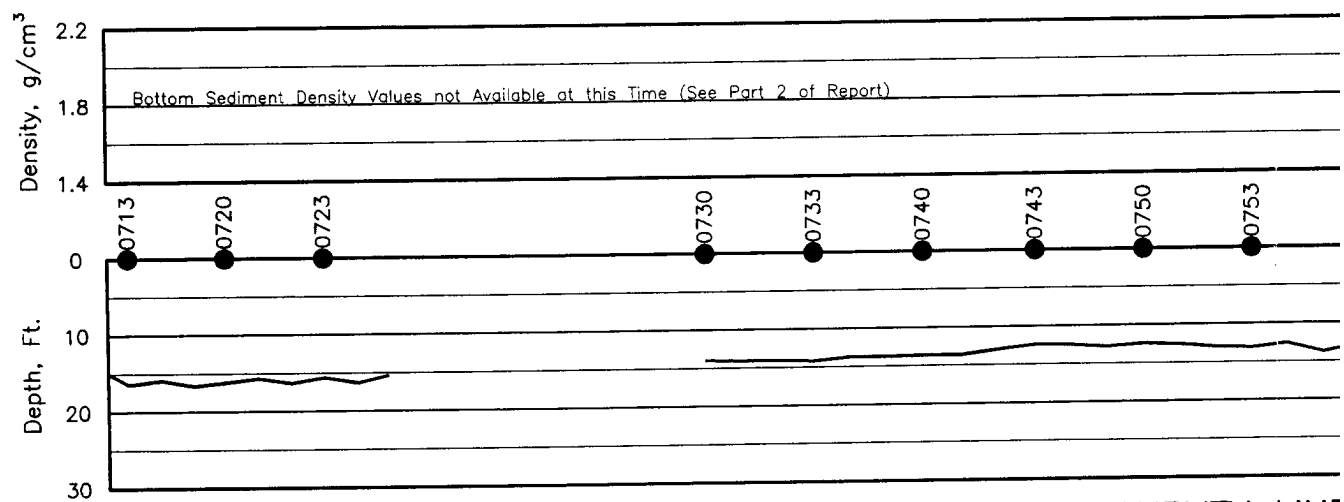


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Vertical Exaggeration X 2



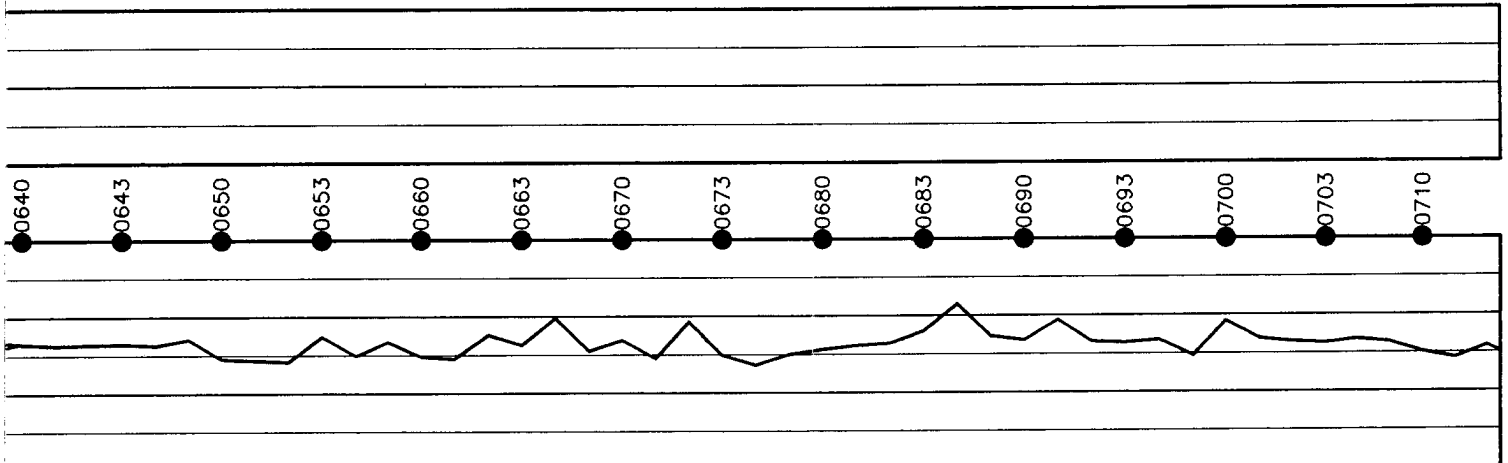
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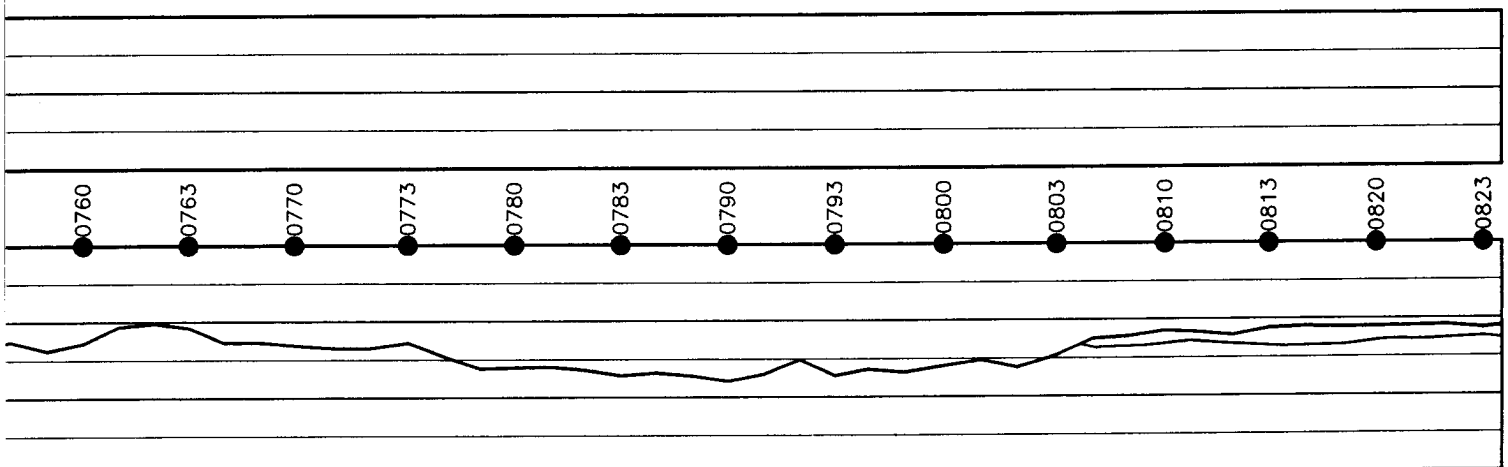
WES SURVEY LINE

PROJECT AREA: POOL 3 NAVIGATION CHANNEL, MONONGAHELA RIVER

2

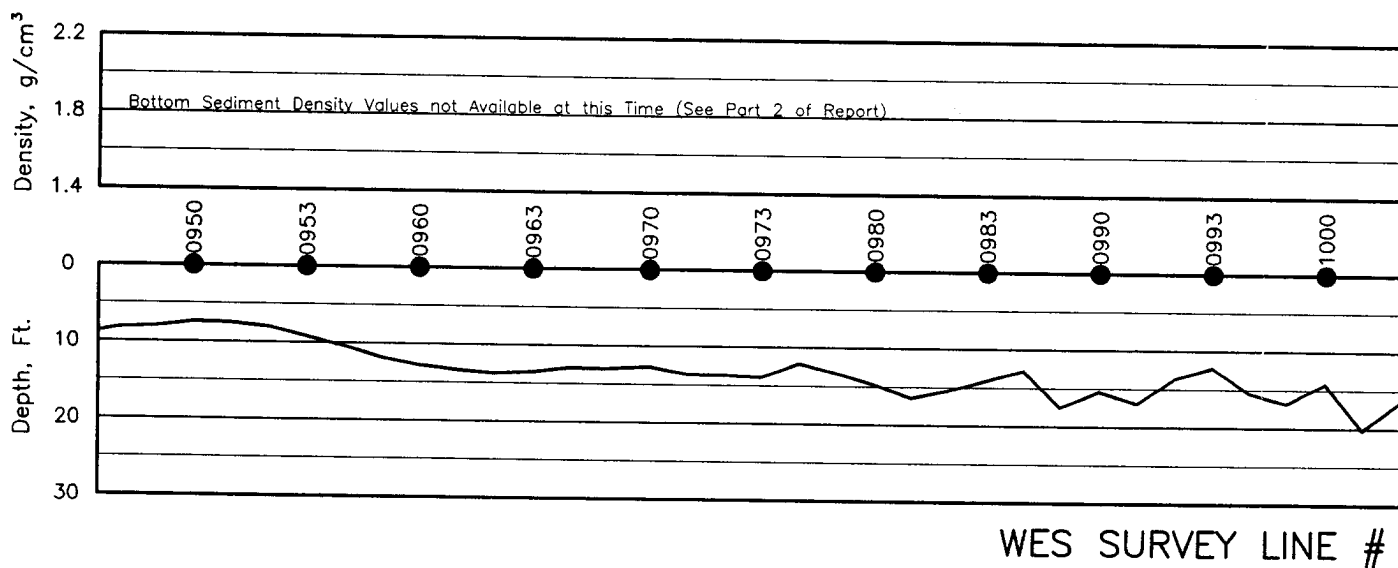
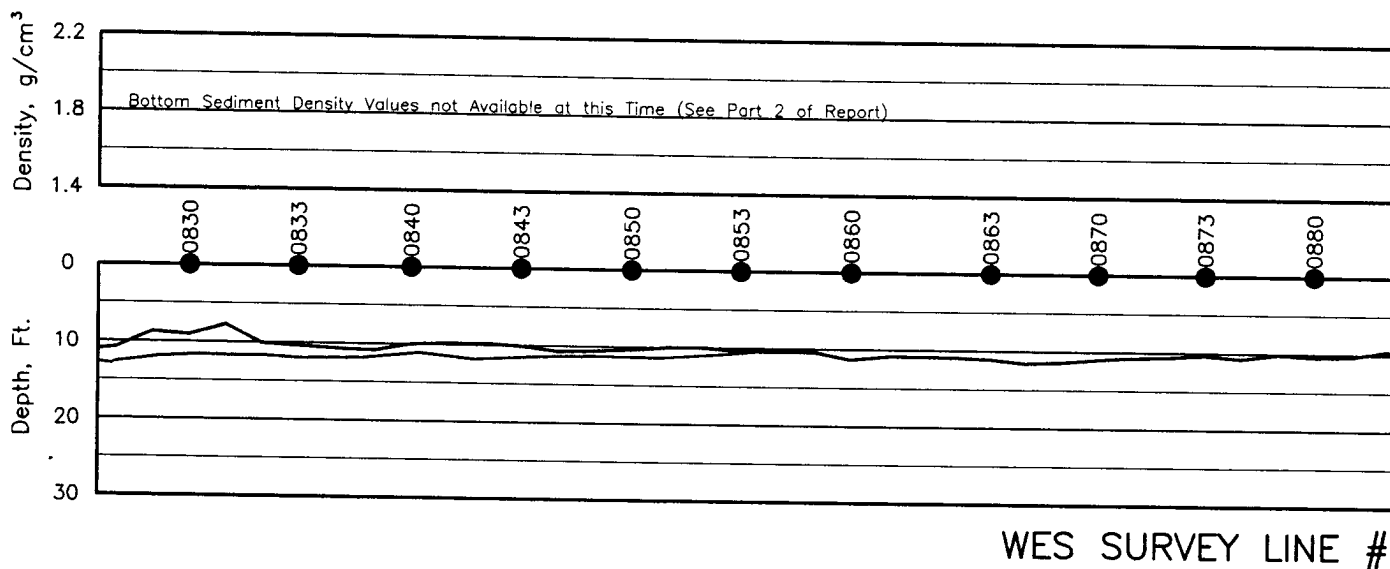


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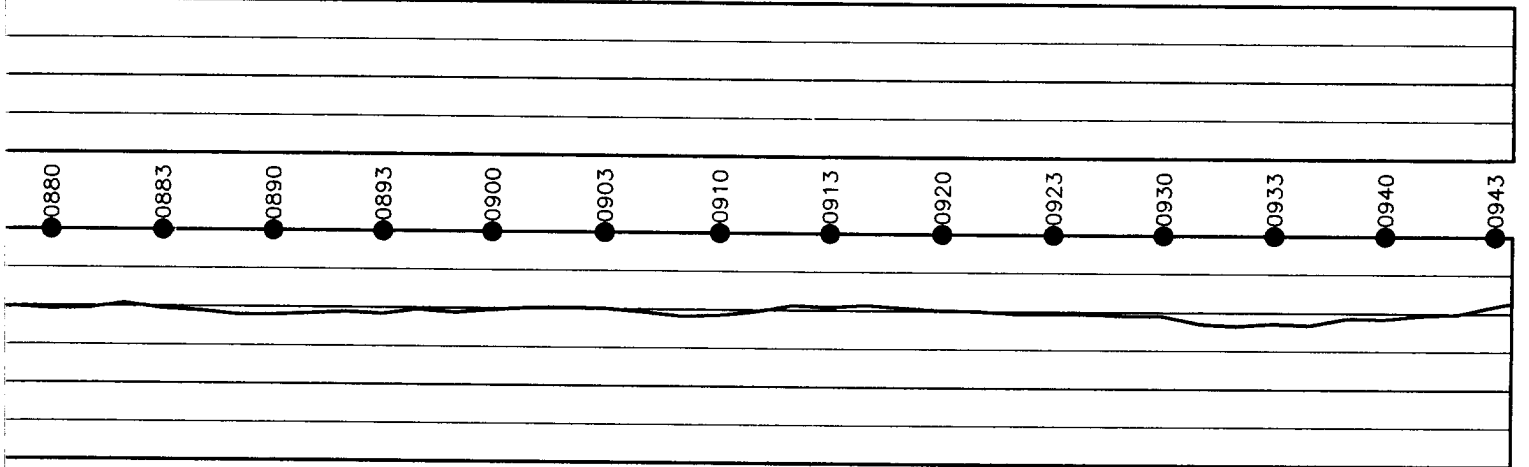
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Vertical Exaggeration X 2

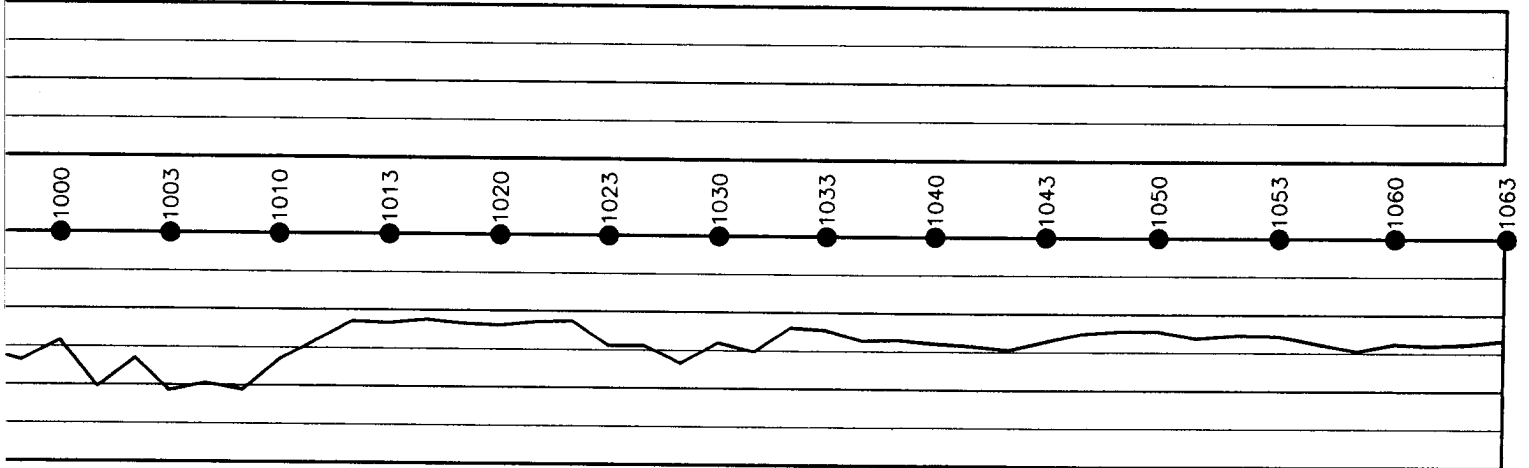


PROJECT AREA: POOL 3 NAVIGATION CHANNEL, MONONGAHELA RIVER, PA

2

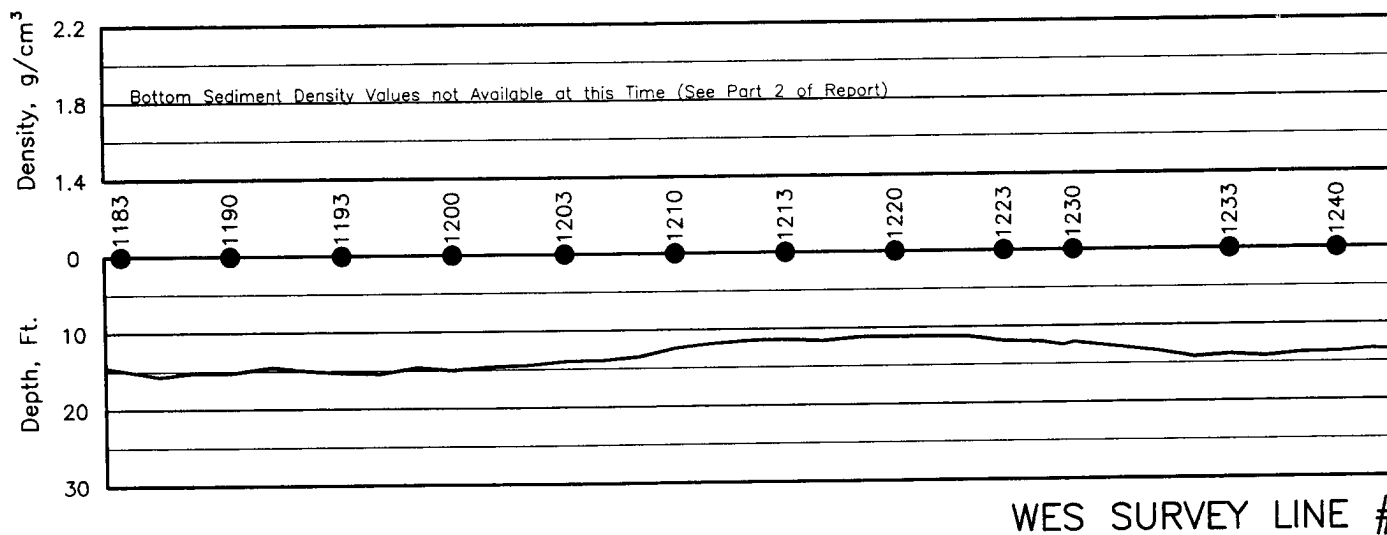
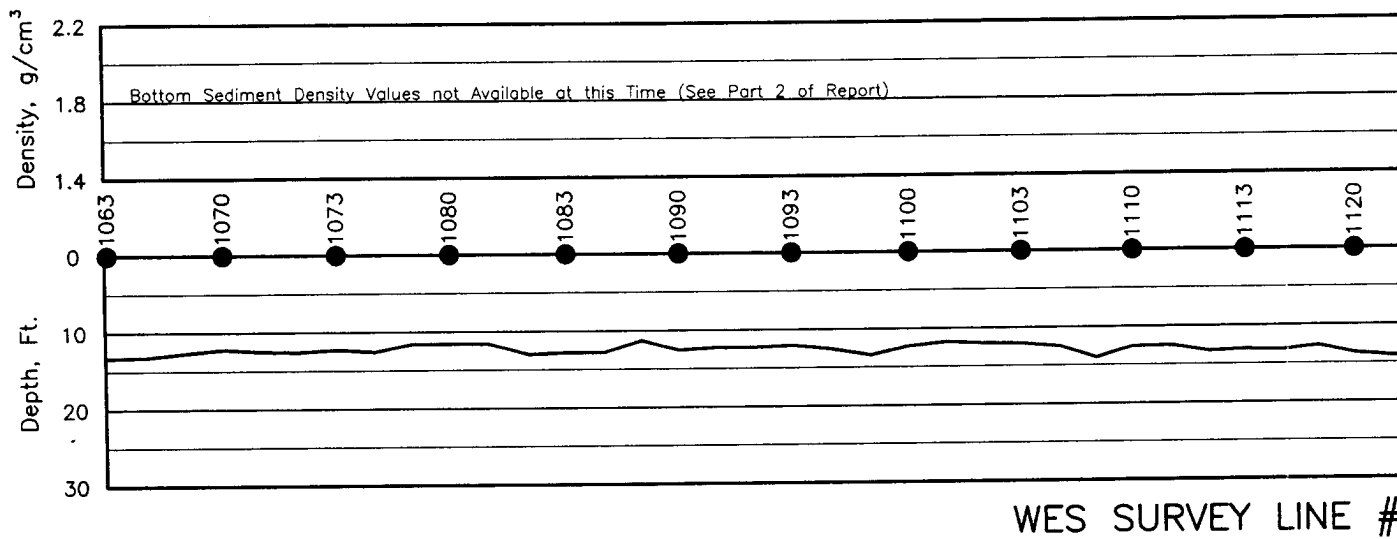


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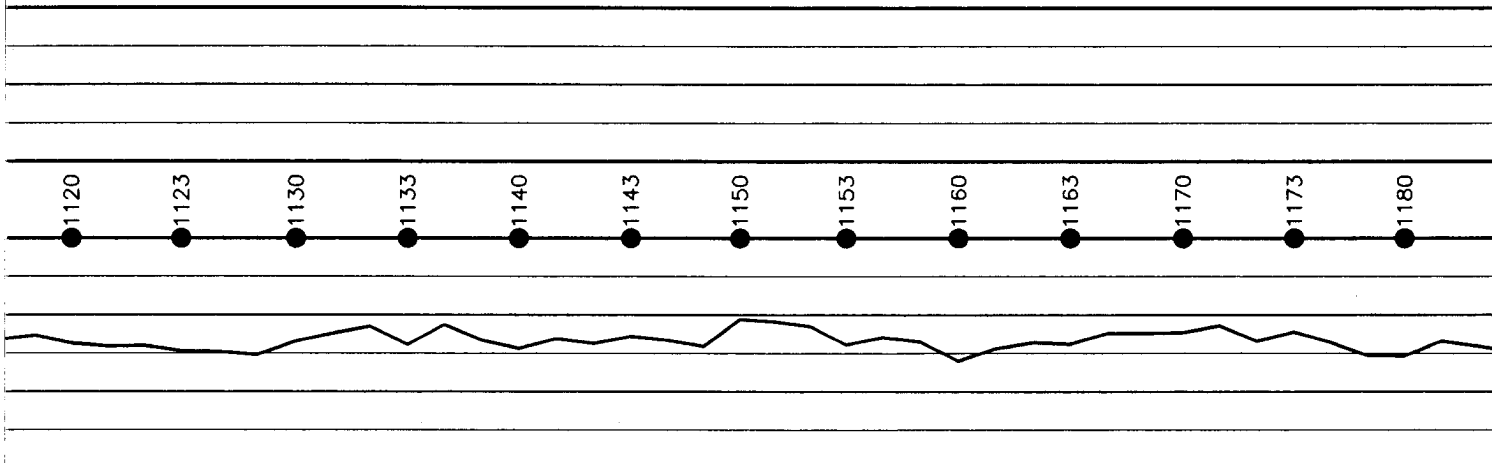
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Vertical Exaggeration X 2

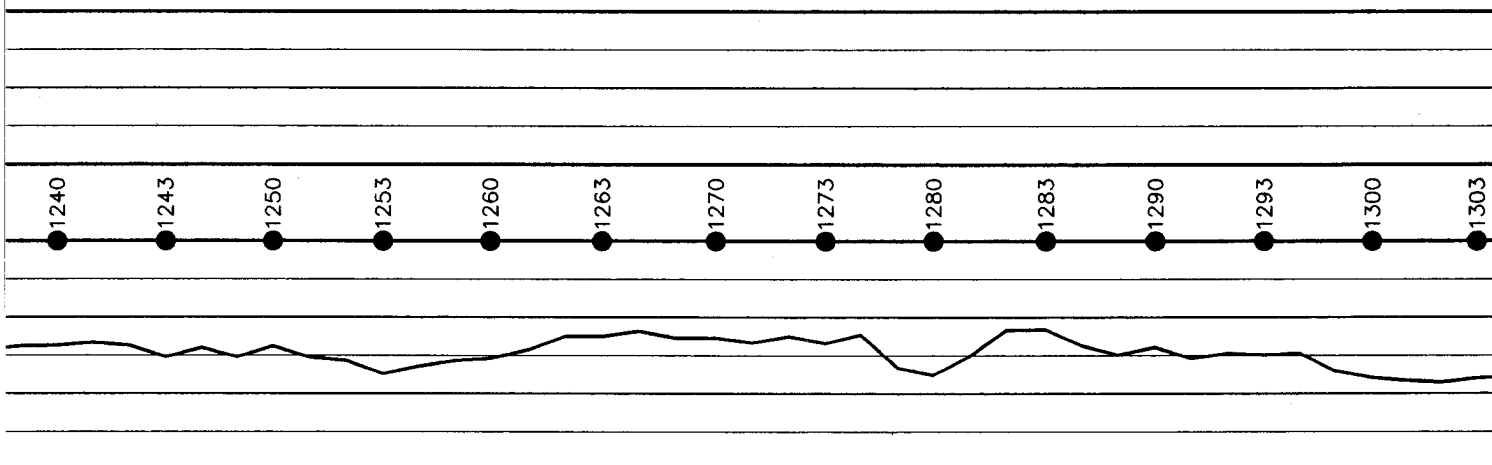


PROJECT AREA: POOL 3 NAVIGATION CHANNEL, MONONGAHELA RIVER, F

2

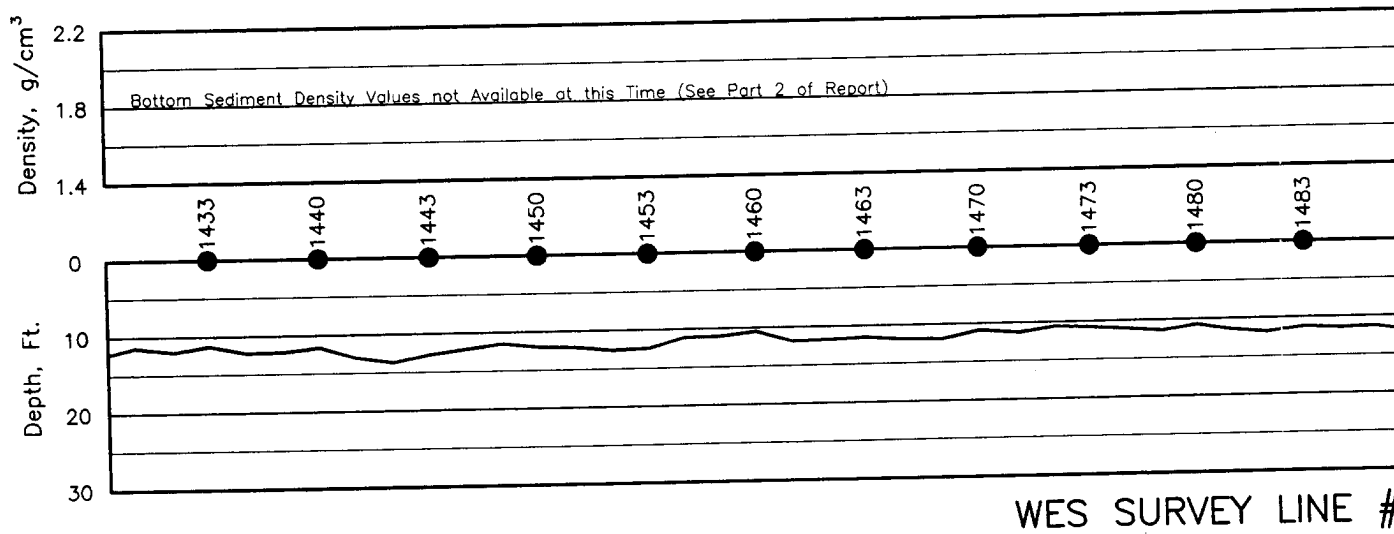
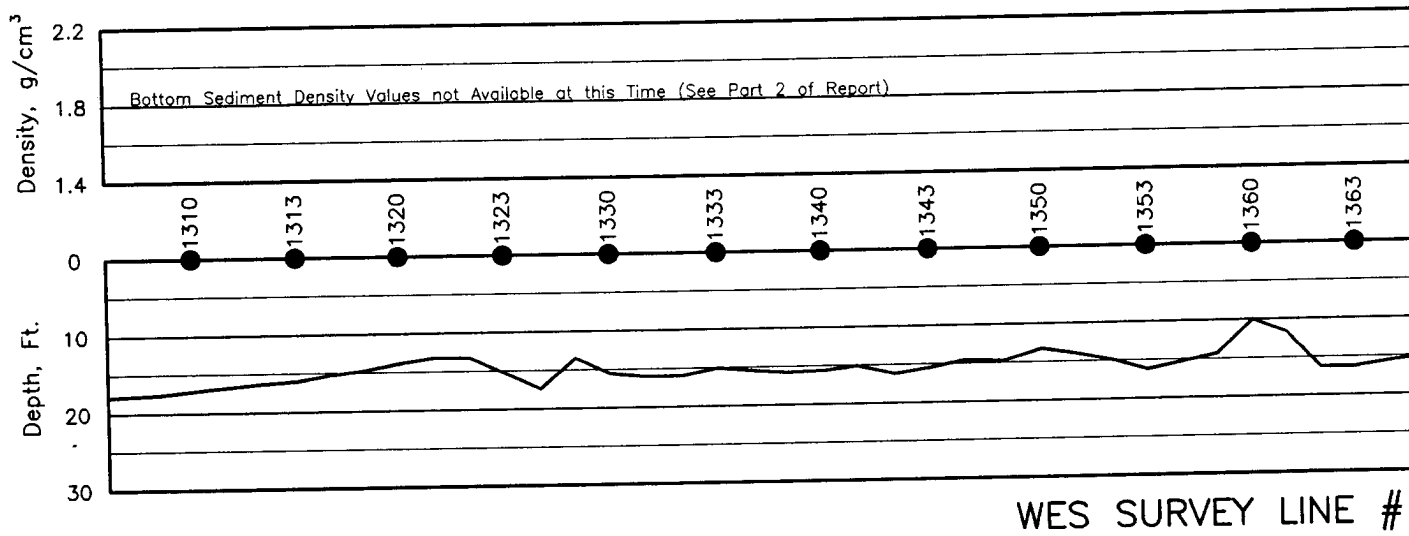


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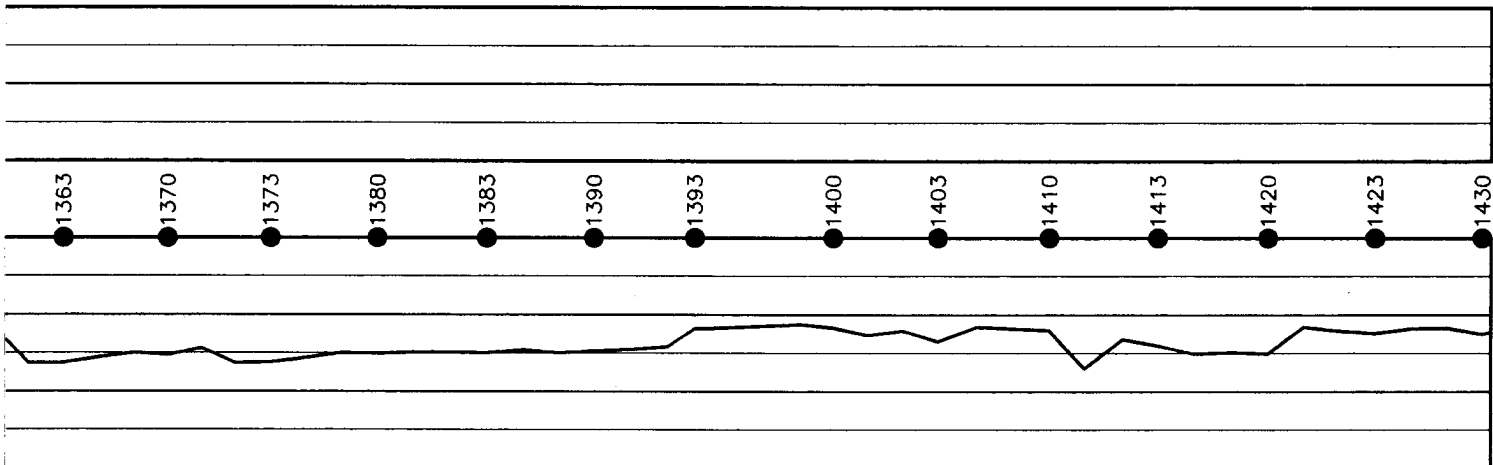
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Vertical Exaggeration X 2

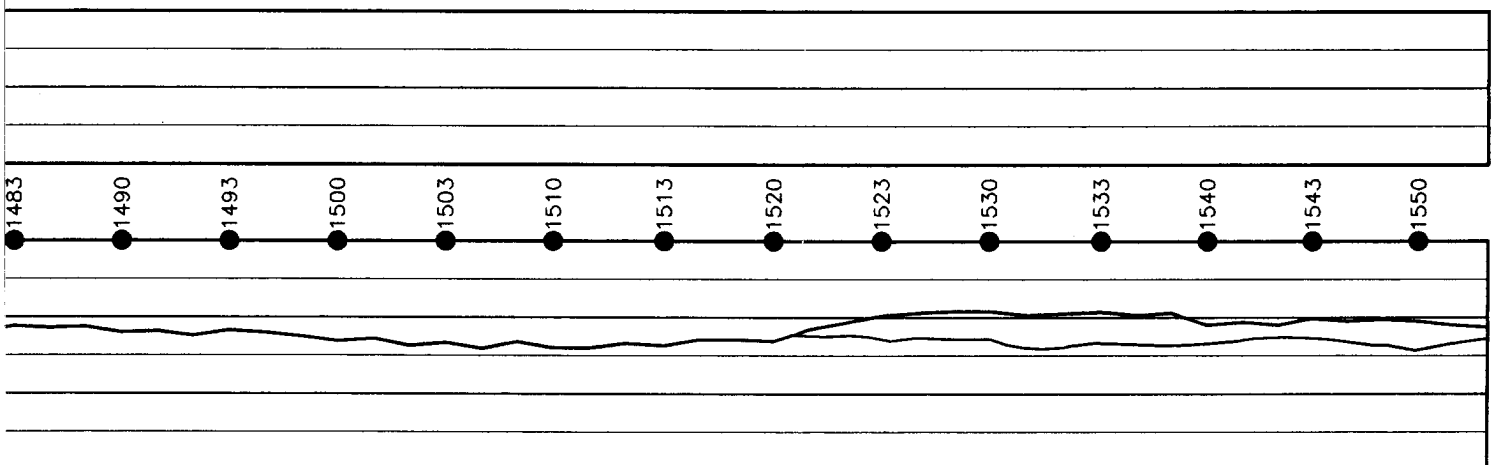


PROJECT AREA: POOL 3 NAVIGATION CHANNEL, MONONGAHELA RIVER, F

2

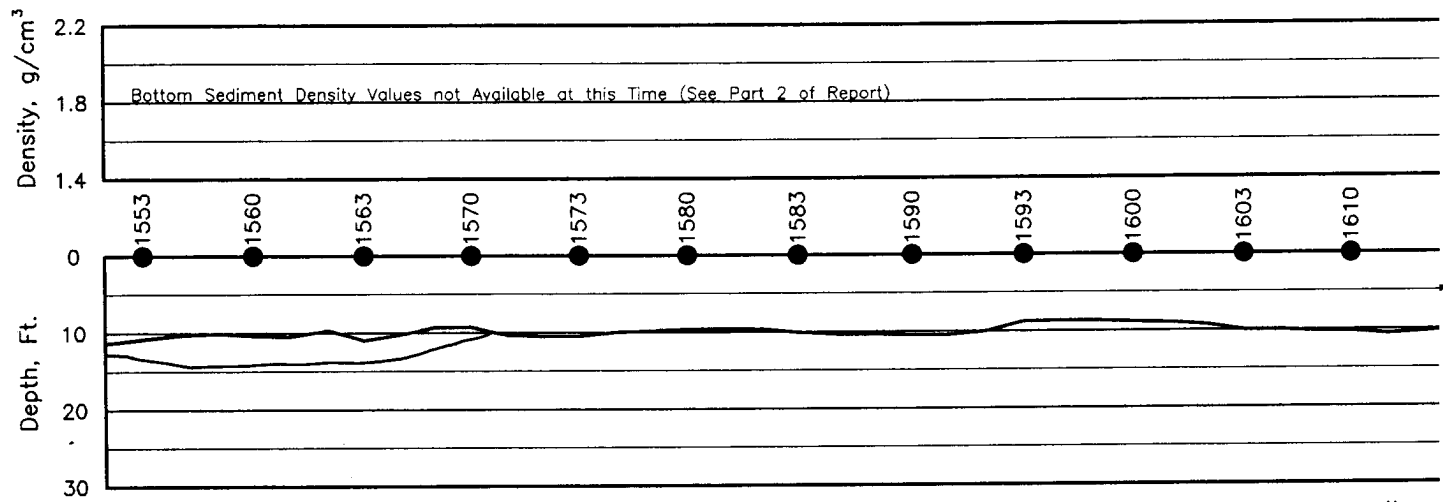


LINE # PP5A (cont)



LINE # PP5A (cont)

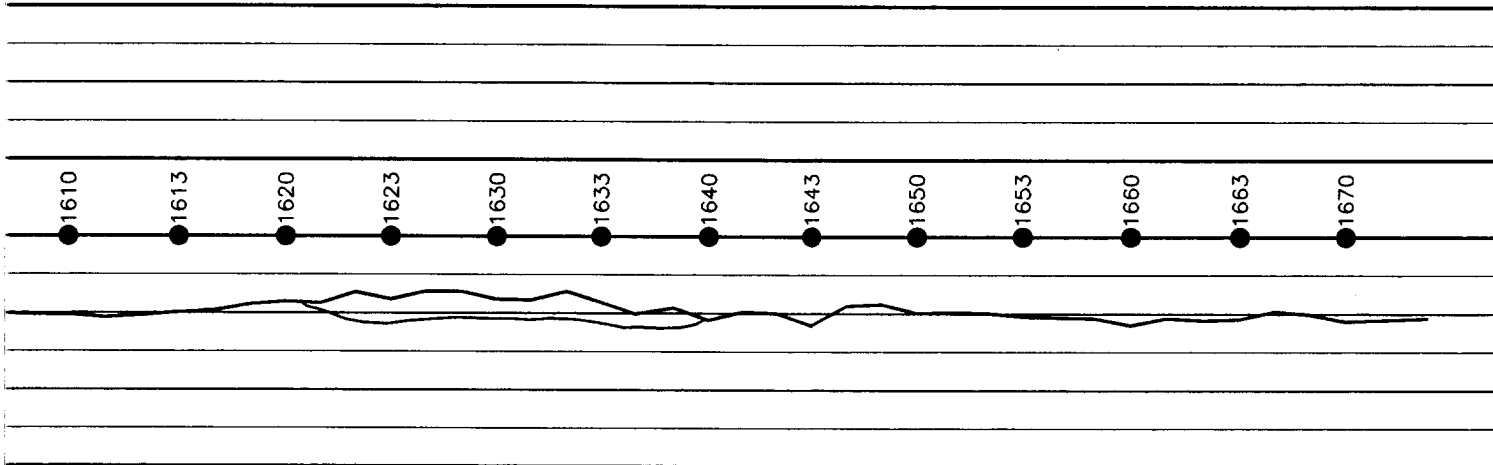
Vertical Exaggeration X 2



WES SURVEY LINE # F

PROJECT AREA: POOL 3 NAVIGATION CHANNEL, MONONGAHELA RIVER, PA.

2



LINE # PP5A (cont)

Vertical Exaggeration X 2

REPORT DOCUMENTATION PAGE

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